

Cross-cutting adaptation policy: a case study of Lyme disease

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Executive Summary

This paper sets out a method for characterising and analysing a cross-sectoral adaptation issue. The draft Scottish Climate Change Adaptation Policy 2019-2024 (SCCAP2) takes a cross-cutting, outcomes-based approach (The Scottish Government 2019a). While this recognises the need to integrate adaptation across sectors, in practice it is not always easy to achieve. This methodology provides a way for the Scottish Government to look across sectors when developing policy. It provides a way to map drivers and impacts across sector, can identify and minimise conflict, and maximise co-benefits.

Lyme disease provides a good example of a cross-cutting issue, and is used as a case study to demonstrate how to analyse wider cross-sectoral adaptation issues.

The drivers and impacts of Lyme disease cut across a number of policy areas including: health, agriculture, forestry, conservation, biodiversity, rural economy, outdoor recreation and tourism.

Changes in land management (e.g. increasing woodland extent) can increase the number of infected ticks. At the same time nature based tourism, which can expose visitors to ticks and infection, is an important contributor to Scotland's rural economy and employment.

Sectoral decisions taken in isolation can potentially conflict with other policy outcomes. It is therefore important to recognise and untangle these cross-cutting issues. An informed approach to Lyme disease that accounts for complexity and interaction can help avoid such conflicts and enable more efficient use of resources.

Method

1. Evidence gathering. Literature review and engagement with stakeholders.
2. Identify actions that influence the risk.
3. Map drivers and impacts across sectors, and relevant policies/policy areas.
4. Identify the conflicts between policies.
5. Map stakeholders, using the mapping of actions and policy areas.
6. Identify mitigating actions to minimise conflict or maladaptation, and realise co-benefits.
7. Stakeholder engagement. A workshop to bring together stakeholder across sectors to jointly inform and sense-check the outcomes of the process.

Key findings

The process and stakeholder workshop highlighted stakeholder engagement as a particularly valuable part of the method. This should include practitioners at ground level, and involve exchange of information both top down and bottom up.

Strengths and weaknesses in the method:

- ✓ Straightforward, transparent and intuitive
- ✓ Avoids duplication of effort
- ✓ Evidence based
- ✓ Can avoid lock-in to a long-term course of action
- ✗ Does not discuss the barriers to change
- ✗ Does not identify stakeholder knowledge gaps
- ✗ Ownership of cross-sectoral policy issues is still unclear

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1. Background: Why look at Lyme disease?

Globally, the impact of vector-borne diseases on human health is likely to increase due to climate change (Ogden & Lindsay 2016). The deer or sheep tick *Ixodes ricinus*, which spreads Lyme disease in Scotland, is ‘the most multicompetent vector in Europe’ transmitting significant diseases to people and livestock (Dobson et al. 2011).

A number of factors related to climate, land-use and ecology have contributed to increased tick numbers and geographic spread, both northwards and to higher elevations (Medlock & Leach 2015; Quine et al. 2011).

In the UK, Lyme disease is already endemic with more than 1000 confirmed cases each year (Medlock & Leach 2015). Incidence is increasing in Scotland (Mavin et al. 2015), due in part to increased exposure as more people pursue outdoor activities. Lyme disease is spread to humans by infected ticks, which are projected to double in abundance or increase by over ten times with 1°C and 3°C climate warming, respectively (Li et al. 2016).

Continuing and improving efforts on Lyme disease is therefore identified as a key policy recommendation for Scotland by the IMPRESSIONS-EU project that investigated strategies for high-end climate change¹ (Rounsevell 2018).

2. Method

Method step-by-step	Lyme disease case study
Step 1: Evidence gathering. Literature review and engagement with stakeholders.	Literature review focussed on Lyme disease and on ticks, the vector that spreads the infection in Scotland. Discussion with scientists.
Step 2: Identify actions that influence the risk.	Cross-sectoral policy drivers including management of landscapes, biodiversity, deer, agriculture, climate change (e.g. peatland), outdoor recreation, health and wellbeing.
Step 3: Map drivers and impacts across sectors, and relevant policies/policy areas.	Complex interactions: e.g. active lifestyles, nature-based tourism, biodiversity, forestry and land use policy.
Step 4: Identify the conflicts between policies	Unintended impacts on Lyme disease risk can result from agro-forestry or woodland expansion, while peatland restoration offers a ‘win-win’ opportunity across multiple policy outcomes.
Step 5: Map stakeholders (using the mapping of actions and policy areas).	Inclusion of policymakers, delivery agencies, scientists, researchers and practitioners including industry bodies provided a range of perspectives and insights. Key policy areas include climate change adaptation and mitigation, public health, agriculture, forestry, animal health, tourism and biodiversity.
Step 6: Identify mitigating actions to minimise conflict or maladaptation, and realise co-benefits.	Examples of mitigating actions for Lyme disease risk can be found in academic literature, other documentary evidence, and in practice. Stakeholders helped provide a reality check, and insights into both incentives for, and barriers to, adoption of these actions.
Step 7: Stakeholder engagement. A workshop to bring together stakeholder across sectors to jointly inform and sense-check the outcomes of the process.	The Lyme disease case study demonstrated the value of bringing diverse stakeholders together as a group, providing an overall picture of complex interactions and how we can move forward.

¹ <http://www.impressions-project.eu/>

2.1 Step 1: Evidence gathering

Evidence gathering can be done in a number of ways, e.g.:

- Review peer-reviewed academic papers.
- Review relevant 'grey' literature from other sources.
- Interview experts.
- Stakeholder engagement, including practitioners.

This case study uses a literature review focussed on Lyme disease and on ticks, supplemented by informal discussion with expert researchers and stakeholders, to sense-check the findings and gather information about ongoing research in Scotland. This scientific evidence provides the basis of the study.

Gaps in research and knowledge also need to be considered, It is also important to be aware of what we don't know when making decisions.

Case study evidence highlights

Habitats

The prevalence of Lyme infection in tick populations is linked to the type of habitat (Bettridge et al. 2013). Woodland provides more favourable conditions for ticks (shade, moisture and vegetation) and also more hosts to feed on. Some studies associate semi-natural mixed and broad leafed woodland with higher rates of tick infection than in coniferous forests, for example among forest workers (Bettridge et al. 2013; Kiewra et al. 2018). Fragmented habitats can produce an 'edge' effect, with more ticks in boundary areas (Millins et al. 2017; Schotthoefer & Frost 2015; Hansford et al. 2017). The way habitat fragmentation affects host movements through the landscape influences the risk (Gilbert 2016). Wildlife corridors provided for connectivity between areas of habitat can also enable the movement of ticks through the landscape.

Similar habitats can have quite different communities of hosts, which can influence tick numbers. Human activity such as deer culling may contribute to these differences (Gilbert 2016).

Urban greening

There is evidence that increasing urban greenspace can increase Lyme disease risk (Millins et al. 2017). It increases likelihood of contact between humans and ticks, as does urban encroachment into woodland areas and green belts (Medlock & Leach 2015). Urban deer and foxes carrying ticks may also interact with people and dogs. A study in Poland suggested that tick numbers and activity levels may be affected by urban heat islands (UHIs). The microclimatic conditions (specifically humidity) and pollution within UHIs were associated with a longer active period, increasing the risk to humans, domestic animals and wildlife (Buczek et al. 2014). Infected ticks have been found in Richmond Park in London (Bunn 2015).

Dog ownership

Domestic pets can contribute to increasing tick numbers in the environment (Skotarczak 2018). For example, domestic dogs have been found to be an important food source for tick larvae in the Alps. This could have potential consequences for tick populations in urban areas (Collini et al. 2016). Scotland has an estimated 653,000 dogs. In 2018, 23% of the population, some 485,000 households, owned a dog².

² <https://www.pfma.org.uk/dog-population-2018>

Health and wellbeing

With no vaccine currently available (Lindgren & Jaenson 2006), prevention of Lyme disease in humans depends on understanding how transmission occurs and how the risk may evolve in a changing environment. Currently, the single most important risk reduction mechanism is individual preventive behaviours (Aenishaenslin et al. 2017). Education and awareness is crucial to encourage both preventive behaviour, and early diagnosis (O'Connell 2010).

Outdoor and nature-based activities

'Scotland's people and nature survey 2017/18' found that over 80% of the population took part in outdoor recreation during the year, with more than half the population doing so on a weekly basis – estimated at more than 500 million visits (Wilson, V. & Seddon 2018).

Because many people take part in nature-based activities there is already high potential exposure to infection. Case studies from Europe show an association between recreation in tick-infested forests and increased incidence of tick-borne disease (Donohoe et al. 2015). Spikes in the incidence of tick-borne disease in parts of Europe have been attributed to weather-driven changes in human behaviour (Quine et al. 2011).

Climate impacts

Temperature affects numbers of infected ticks in two ways (Li et al. 2016):

1. Direct effect on activity, phenology (seasonality) and survival.
2. Influence on habitat suitability and host species population (numbers and diversity).

Changes in seasonality of tick activity with rising temperatures have been observed across Europe (e.g. Jaenson et al. 2012; Hansford et al. 2017). Extreme weather in particular will affect tick numbers and activity. Milder, wetter winters could enable a longer active season, while ticks will not be active in hot, dry summers (Medlock & Leach 2015). However, complex interacting drivers on ticks and their host species make prediction of impacts uncertain (Semenza & Suk 2018; Medlock & Leach 2015).

Ticks may move uphill in response to warmer temperatures, as has happened elsewhere. As more 'competent hosts' such as red grouse and mountain hares are found at higher elevations, this could increase infection rates in tick populations (Gilbert 2016).

2.2 Step 2: Identify actions that influence the risk

What impacts numbers of infected ticks?

Cross-sectoral policy drives the management of landscapes and habitats for conservation; to improve biodiversity, ecosystem services or to manage invasive species (Millins et al. 2017). The way we manage our landscapes affects both tick ecology and the likelihood of human exposure (Barrios et al. 2013). Figure 1 illustrates some of the policy drivers.

Deer management

In a changing climate, deer numbers might increase in response to warmer temperatures at higher altitudes (Li et al. 2016). However, the management of deer, other game, and habitats, will probably be a larger influence than climate upon the rate of Lyme infection in ticks (Medlock & Leach 2015).

In general, higher deer populations are associated with a higher risk of Lyme disease (Gilbert 2016). Deer and other large mammals are a major food source for ticks and are associated with large tick numbers (Gilbert 2016). However, they do not transmit the Lyme infection to feeding ticks. The infection is transmitted by 'competent hosts' such as birds and rodents.

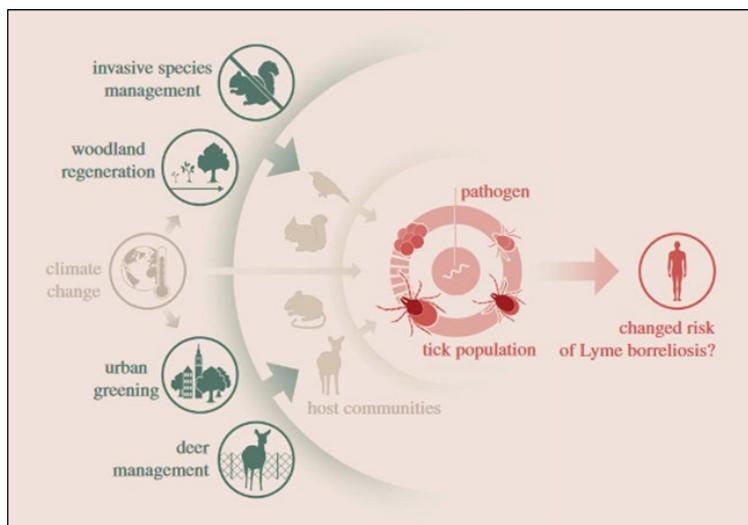


Figure 1. Overview of selected policy actions that may affect the risk of Lyme disease (Diogo Guerra, in Millins et al. 2017).

Peatland restoration

The restoration of peatland, from previously forested area, can significantly reduce tick numbers. The canopy cover and ground vegetation available in forests provide micro-climates and habitat for a number of smaller tick hosts, as well as habitat for deer. By contrast, peat bog is a much less suitable habitat (Gilbert 2013).

Health and wellbeing: outdoor and nature-based activities

A warmer climate may also lead to an increase in outdoor recreation and activities, increasing human exposure to ticks (Li et al. 2016). Spikes in the incidence of tick-borne disease in parts of Europe have been attributed to weather-driven changes in human behaviour (Quine et al. 2011). Climate may also drive land use change that in turn influences outdoor activity.

2.3 Step 3: Map drivers and impacts across sectors/policy areas

Figure 2 provides an overview of the interacting drivers that influence Lyme disease risk.

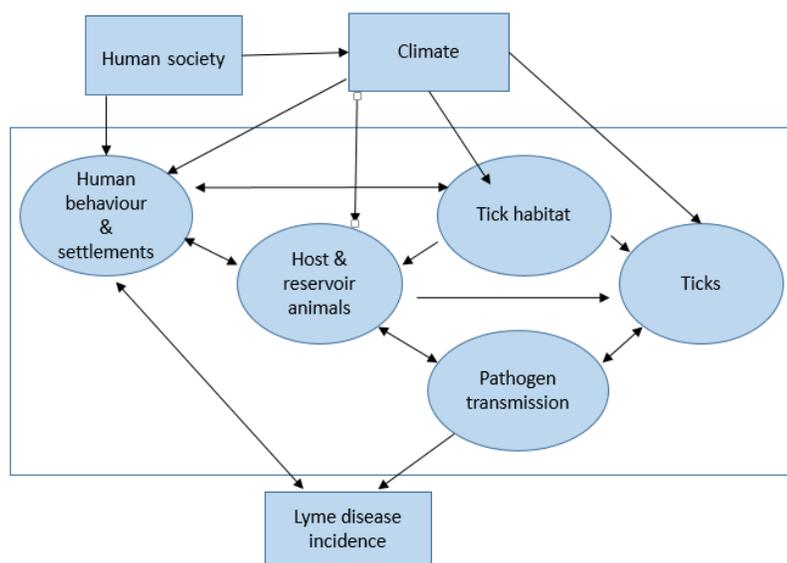


Figure 2. Overview of relationships between society, climate change, ecological and demographic changes, and changes in Lyme disease incidence (adapted from Lindgren & Jaenson 2006)

The complex interplay among drivers of Lyme disease risk span policy areas from public health to deer management to urban greenspace. Key policy areas are shown in Figure 3. Many policy areas can influence several of the elements that influence Lyme disease risk. For example, climate change mitigation (Scotland’s [Climate Change Plan](#)), can potentially impact all of the elements in this overview: climate, ticks, host and reservoir animals, tick habitat, human society, human behaviour and settlements, and pathogen transmission.

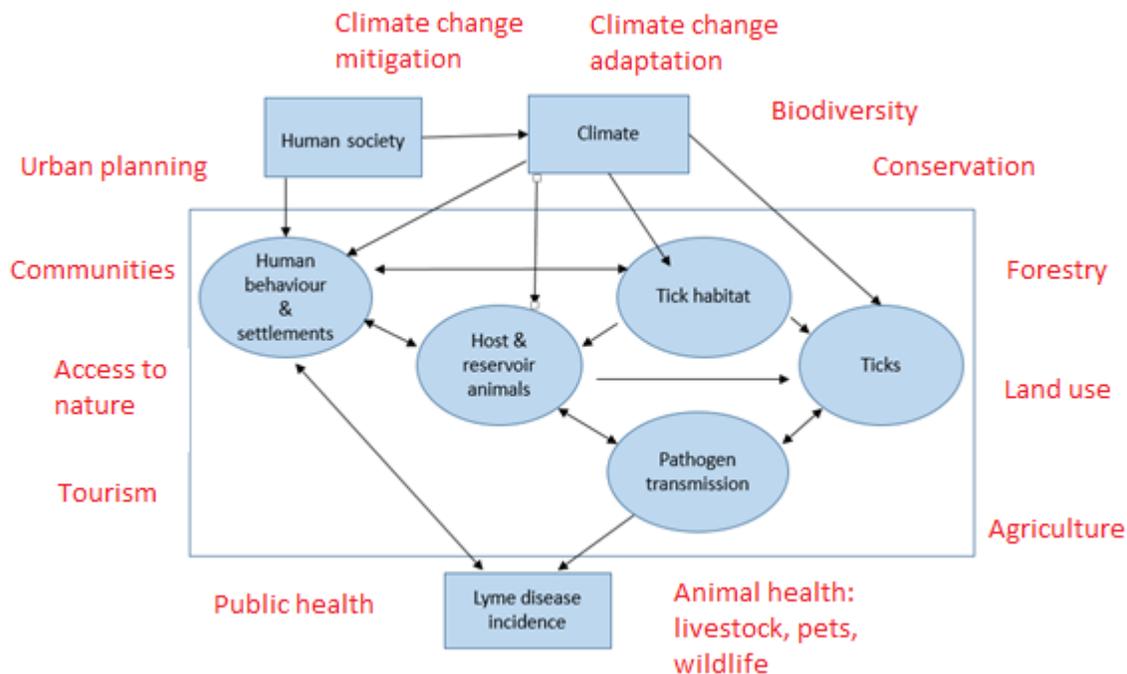


Figure 3. Overview of relationships and interlinked policy areas

Relevant policy outcomes such as active lifestyles, nature-based tourism and outdoor activities contribute to several of the National Outcomes included in Scotland’s [Performance Framework](#); Environment, Health and Communities. Progress is measured in some of our national performance indicators:

- Access to green and blue space
- Visits to the outdoors
- Biodiversity
- Physical activity

Case study mapping of drivers and impacts

Woodland

Changes to woodland type can affect tick populations, and increasing the extent of woodland may increase the risk. Studies have found that ticks in deciduous and mixed woodland are significantly more likely to carry Lyme infection, compared to those in other habitats (Bettridge et al. 2013).

Agriculture

Farmers have an increased risk of exposure to Lyme disease due to the nature of their work (NFU Scotland 2017). In addition to Lyme disease, ticks transmit several livestock diseases including Louping ill, tick-borne fever, babesiosis and tick pyaemia (Rocchi, M. and Reid 2015).

Health and wellbeing: outdoor and nature-based activities

Most people taking part in outdoor recreation felt their health benefitted from the visits, which represented a substantial contribution to the Scottish Government’s physical activity targets (Wilson,

V. & Seddon 2018). *Evidence supports the benefits to health and well-being associated with visiting and taking exercise in natural environments* (Quine et al. 2011).

'Green exercise' is jointly promoted by Scottish Natural Heritage, Forestry Commission Scotland and NHS Health Scotland in [Our Natural Health Service](#).

The combination of a warmer climate, social factors and the pursuit of policy goals such as active lifestyles, nature-based tourism and activities may all increase participation in outdoor activities (Li et al. 2016).

2.4 Step 4: Identify conflicts between policies

Step 3 highlights the complex policy landscape. Multiple policy aims can drive actions that influence Lyme disease risk, and these can have unintended impacts on other sectors. Step 4 identifies these conflicts, such as reducing Lyme disease risk versus other desired outcomes, and also any 'win-wins' – adaptation options that contribute to more than one policy goal.

Case study conflicts and synergies

Agriculture

Agricultural policy is a major driver of land management, with farming covering over 70% of Scotland's land. The EU Common Agricultural Policy (CAP) and the Scottish Rural Development Programme are significant influencers of agricultural practice. Agri-environment measures and support of High Nature Value farming systems provide benefits across policy areas, such as enhancing ecosystem services and contributing to the objectives of the Scottish Biodiversity Strategy. These are detailed in the ClimateXChange narrative [Sustainable Agriculture](#) (ClimateXChange 2016a). However, these measures can also affect Lyme disease risk.

Policy decisions, spanning agriculture and other sectors, can drive encroachment of woodland onto farmland. This could result from changes in agricultural subsidies leading to reduced livestock pasture management, incentives for agro-forestry, or the drive to increase woodland to help mitigate climate change. While agro-forestry can provide a number of benefits, the boundary between pasture and woodland provides ideal tick habitat with both wildlife and livestock hosts, increasing the risk to livestock and farmers (Skuce, P. and Wells 2016). A study in Norway found increased tick numbers, and more ticks biting lambs, in pastures close to tree cover (Gilbert et al. 2017).

Acaricides (chemical pesticides) are commonly used to reduce livestock exposure to tick bites. Sheep treated with acaricides may act as a 'tick mop' thereby reducing tick numbers and Lyme disease risk. Maureen Watt, then Minister for Mental Health, linked the decoupling of hill farm support and associated reduced numbers of hill sheep to an increase in Lyme cases in 2006 (The Scottish Parliament 2017; NFU Scotland 2017).

A policy change in the early 1990s ended the mandatory use of sheep dips. This has been linked to the reduced use of acaricides on sheep. The use and disposal of sheep dip chemicals can be problematic and is carefully regulated due to the potential damage to biodiversity, particularly the aquatic environment, water regulation and human health (Quine et al. 2011; Claffey 2018; SEPA 2006). This highlights the need for balance between sectoral aims: the control of tick populations to reduce Lyme disease risk, versus the potential adverse impacts of control measures on other policy objectives.

Forestry

The Scottish Government is targeting an increase in the extent of woodland as part of the [Climate Change Plan](#). Increased diversity of tree species is promoted as an adaptation strategy to improve resilience to a changing climate and pest and diseases, described in the ClimateXChange [forestry narrative](#). However, the previous steps indicate the potential for these strategies to increase Lyme disease risk, if mitigating measures are not in place.

Peatland restoration

Management actions that speed up peatland restoration in formerly forested areas will also hasten the removal of ticks from the landscape. This can simultaneously contribute to several policy aims; climate regulation, biodiversity, water regulation and cultural benefits together with pest and disease management (Gilbert 2013). Recognising the ‘win-win’ cross-policy benefits may help provide mechanisms to fund an expansion of action.

Tourism

Scotland’s [landscapes and nature](#), wildlife and outdoor activities are major tourism draws.

Nature-based tourism increases the likelihood of exposure to ticks and infection. Where tourism is largely based on nature-based activities, Lyme disease risk could potentially affect destination sustainability (Donohoe et al. 2015).

The [World Health Organisation](#) advises travellers to avoid tick-infested areas and exposure to ticks, and studies have found that perceived risk can affect travellers’ choice of destination (Donohoe et al. 2015). Tourism workers who spend much of their working life outdoors are at higher risk, which is a concern for employers (ibid).

This is significant for Scotland’s rural economy. A 2010 Scottish Natural Heritage report found that *‘tourist spending on nature-based activities was worth £1.4 billion per year, nearly 40% of all tourism spending in Scotland, and accounted for 39,000 full-time equivalent jobs (Bryden et al. 2010).*

Woodlands provide a particularly favourable environment for ticks (discussed in the ‘Habitats’ section above). Forest-related recreation and tourism was worth £18 million to the rural economy in 2015 (The Scottish Government 2019b). It is therefore vital to find ways to manage and reduce the risk to people visiting our forests and woodland.’

Adaptation to climate change

Adaptation to climate change is characterised by its cross cutting nature. This presents an implementation challenge. It is important for adaptation strategies to avoid indirect effects that may exacerbate direct climate impacts (Medlock & Leach 2015).

For example, Public Health England have noted increasing numbers of ticks in urban areas. Such tick problems could be worsened by adaptation strategies promoting urban greenspace and wildlife corridors bringing ticks into these spaces (Medlock & Leach 2015). However, urban greenspace and wildlife corridors offer important adaptation benefits: flood alleviation, shade, reduction of urban heat island effect and health benefits, together with benefits to biodiversity, landscape amenity and reduction of pollution.

Many actions can have potential unintended consequences for Lyme disease risk. To avoid these, policy and decision makers need to consider cross-policy relevance and impacts.

2.5 Step 5: Map stakeholders

Relevant stakeholders can be identified and engaged during each step of the process. By the time Steps 3 and 4 are completed, mapping drivers and impacts across sectors, and conflicts between policies, a comprehensive list should have emerged. Stakeholders should represent each of the key policy areas and include three specific groups:

- SG policymakers
- Representatives of delivery agencies (including local authorities)
- Experts/specialist advisers

For Lyme disease risk, the key policy areas include:

Public health; climate change adaptation; climate change mitigation; agriculture; forestry; animal health; biodiversity; conservation; land use; tourism; and rural economy.

2.6 Step 6: Identify potential mitigating actions to minimise conflict or maladaptation, and realise co-benefits

Both the academic literature and documentary evidence (grey literature) provide examples of mitigating actions and options with cross-policy benefits.

Deer management

Deer management activities including fencing and culling can reduce tick numbers and Lyme disease risk (Millins et al. 2017; Hofmeester et al. 2017). Fencing is likely to be an attractive option close to urban and recreational areas and tourist hotspots, but tends to be less acceptable and less practical in the wider landscape, for example in National Parks (Quine et al. 2011). The impacts of different management options should be considered on a case by case basis. Fencing can negatively impact on access for walkers, public safety, deer welfare, biodiversity, landscapes and cultural heritage. It can also be detrimental to protected species such as badgers. And for large areas fencing is unlikely to be cost-effective (Scottish Natural Heritage n.d.). Culling of deer can also be controversial. Deer are an iconic Scottish species and an important [nature based tourism](#) attraction. Cross-policy area thinking and engagement with stakeholders is therefore crucial. Furthermore, solutions will have to be tailored to varying local situations.

Moorland management

Tick management initiatives such as the culling of mountain hares have been employed on grouse moors (Quine et al. 2011). Provided any movement of ticks to higher altitudes is anticipated and monitored, these types of actions could be deployed to mitigate the increased risk.

Forestry

Increasing woodland close to urban areas may provide tick habitat and increase tick numbers. Visiting people and dogs may contribute to spreading the ticks. However, as it provides access to greenspace for health and wellbeing, it is a desired policy outcome. Potential solutions include woodland management techniques that can help reduce the risk to people (Medlock & Leach 2015).

Monitoring of tick numbers and infection is important for targeting control strategies and awareness campaigns (Millins et al. 2017; Bartosik et al. 2011). Given the risk in urban areas, awareness raising could be focussed on users of urban parks and greenspace, and on dog owners. Urban planners should also be made aware of the potential risk, so that mitigating measures can be considered in potential risk areas (Gilbert 2016).

Dog ownership

Dog owners are clearly an important group to target in awareness raising. This was acknowledged in the 2017 submission of the main national veterinary associations to the Scottish Parliament (BVA, BSAVA 2017). The veterinary associations stressed the need for collaboration with the medical professionals, animal owners, Government and local authorities together with landowners and other stakeholders to raise awareness and improve testing and treatment of Lyme disease. There is concern that many pet owners are not aware that dogs can be affected by tick-borne infections and that both dogs and humans can contract Lyme disease. Vets have an important role in advising pet owners about preventive measures, the need to examine their pets and themselves after walks, and correct tick removal. The previous requirement for tick treatment has been removed from the Pet Travel Scheme, increasing the risk of tick-borne diseases reaching the UK. This includes Lyme disease and other diseases that may become a greater risk in a changing climate (ibid).

Agriculture

Options to reduce the risk to livestock include maintaining larger areas of pasture without shrubs or trees, and avoiding woodland encroachment next to pastures. This presents a conflict with measures promoted for multiple policy objectives.

In particular, agro-forestry provides multiple benefits, detailed in [Agro-forestry in Scotland – potential benefits in a changing climate](#) (Perks et al. 2018):

- Climate change mitigation: Sequestration of carbon; help achieve an increase in woodland cover from 18% to 21% by 2032, a target in the 2018 [Climate Change Plan](#) (The Scottish Government 2018)
- Climate change adaptation: Improve resilience by reducing soil erosion, providing shelter for animals and crops, reduce flood risk, and diversification of farm income.
- Biodiversity: diversify habitats and provide connectivity for wildlife. In a changing climate, this can help species move between areas of suitable climate space (see [Tracking suitable space in a changing climate](#) (ClimateXChange 2016b)).
- Pests and diseases: Help tackle crop pests by providing habitat for predators.
- Soil: Hedges and shelter belts help prevent soil erosion, as well as providing landscape amenity and cultural benefits.

Reconciling these various objectives and achieving policy outcomes requires a careful balancing of competing issues, and recognition of the cross-sectoral impacts of the various options.

While acaricides are commonly used to reduce livestock exposure to tick bites, alternatives are increasingly being sought. Habitat management, keeping livestock away from tick-infested areas or using biological controls (tick predators or pathogens) on grazing land are all options (Gilbert et al. 2017).

An example solution is put forward by Gilbert, who suggests targeting the use of biological controls, or acaricide treatment of livestock, close to tree cover (Gilbert et al. 2017). Careful targeting of acaricides limits the detrimental environmental impacts associated with their use while protecting the most at-risk livestock, and still gaining the diverse benefits of agro-forestry.

Tourism

It is obviously important to inform tourists about local health risks and to encourage sensible precautions. However, if people are discouraged from visiting then the rural economy and livelihoods may suffer. And people would miss out on the health and wellbeing benefits of taking part in nature-based activities, impacting negatively on these policy outcomes.

Various studies have found that knowledge about Lyme disease does not necessarily lead to visitors taking precautions to avoid tick bites. However, timely information may be more effective. A US study found that visitors provided with education about Lyme disease on the ferry to Nantucket Island in Massachusetts were significantly more likely to take preventive action during their stay, and subsequently reported lower rates of Lyme infection (Donohoe et al. 2015). This approach could be adapted for Scotland, with provision of educational brochures and information at transport hubs, visitor centres, car parks and picnic areas as well as on ferries.

Tick control management around tourist attractions can include wildlife management such as fencing to exclude deer, reducing vegetation height close to paths and removal of leaf litter (Donohoe et al. 2015; Quine et al. 2011).

Public health

Awareness-raising should encourage the taking of precautions and safe tick removal, but not put people off outdoor activity (Quine et al. 2011). Scottish Natural Heritage recognise the need for balance and proportionate messaging that also recognises the benefits of outdoor recreation (SNH 2017).

The challenge for policy is 'how we use these (control) measures alongside managing greenspace for nature and the health and well-being of the public' (Millins et al. 2017). Knowledge of the spatial patterns of Lyme disease risk can help more effective targeting of awareness campaigns and control strategies (Gilbert 2016).

Those at high risk include outdoor workers, such as farmers, foresters and gamekeepers, and those visiting the outdoors for recreation. Public health authorities can address the risk of Lyme disease through communication, improved awareness, diagnosis and treatment. Maintaining and increasing awareness among GPs is important, even in low-risk areas, as patients may travel to take part in outdoor activities.

Land-based organisations can play an important role in risk communication (Quine et al. 2011). Employers of outdoor workers such as Forestry Commission Scotland provide advice and training on Lyme disease to their employees.

A number of public bodies and outdoor-related organisations provide awareness-raising information and advice. Some examples are:

- Mountaineering Scotland <https://www.mountaineering.scot/safety-and-skills/health-and-hygiene/ticks>
- Ramblers <https://www.ramblers.org.uk/advice/safety/insects.aspx>
- Walkhighlands <https://www.walkhighlands.co.uk/news/highland-council-issues-lyme-disease-warning/0013409/>
- NHS Inform <https://www.nhsinform.scot/healthy-living/outdoor-health/bugs-and-germs/avoiding-bugs-and-germs-outdoors>
- Highland Council provide advice and a free tick removal tool to residents on request.

2.7 Step 7: Engaging stakeholders

There are a variety of ways of engaging with stakeholders on the actions identified in Step 6. A combination of on and off-line methods should be considered and used together.

A workshop bringing stakeholders together is used to test and sense-check the methodology and findings was used for the Lyme case study. This setting enables stakeholders across different sectors to interact with each other. The stakeholder groups mapped in Step 5 provide a breadth of expertise and practical knowledge.

Tapping into cross-sectoral experience helps build an understanding of competing priorities and limitations. Stakeholders can help identify opportunities, conflicts, synergies and trade-offs between alternative courses of action.

3. Workshop: Testing the method

We held a workshop with two aims:

1. Test the method through stakeholder input and feedback.
2. Connect stakeholders working across the relevant policy areas for Lyme disease.

The workshop structure followed the method step-by-step, gathering views on each step. The workshop then looked at managing Lyme disease through three example issues: Tourism; Deer and moorland management; and Adaptation to climate change – urban greening and woodland.

3.1 Key feedback on the method

Strengths

- Enables more collaborative working
- Identifies policy sectors to involve in developing potential mitigating actions.
- Good for addressing policy conflicts. Without this policy may not be developed.

Weaknesses

- Stakeholders should be consulted earlier in the process.
- The cross-sectoral process does not have an owner.

Suggestions and Insights

- There is added value in bringing in practitioners and on-the-ground stakeholders, to gather grass-roots observations, to feedback cross-sectoral knowledge, and to encourage change in practice.
- Policies operate across different timescales. Lock-in to a long-term decision or course of action is a key consideration. In cross-sectoral decision-making, focus should be on the long-term decisions, not the more fluid, self-correcting things, such as awareness of impacts leading to behaviour change.
- Quantify or balance competing policy aims to inform trade-offs and compromises.
- The way in which conflicts and co-benefits are presented is key to getting stakeholder buy-in; frame the issue around stakeholder interests.
- Stakeholders recognised the need for both top-down and bottom-up contributions. Scottish Government input can provide a reality check in terms of policy ambition. Engaging with practitioners can provide a rich source of information about the issue on the ground, and attitudes and behaviours. This helps identify potential barriers and enablers.

3.2 Applying the findings

Developing the Method

Insights from the workshop have informed changes and enhancements to the method. These have been incorporated:

- Earlier engagement with stakeholders, maintained throughout the process.
- Broader engagement, including practitioners at ground level. Use this to gain knowledge to feed back into the process, and to stimulate debate and change.
- Gather evidence on barriers to different adaptation options from stakeholders.
- The order of steps has been changed, with 'Map stakeholders' now taking place before 'Identify potential mitigating actions', in light of the workshop discussion around how to benefit from stakeholder engagement.

Engaging with stakeholders

For effective engagement, it is important to speak to stakeholder concerns; frame discussion around their priorities.

Key outstanding issues

A notable challenge is the lack of ownership of cross-sectoral problems and unintended consequences for policy.

The case study provides a good example. Lyme disease is a key public health issue. However, the public health sector is not empowered or equipped to deal with the ecological issues. As well as the types of groups and stakeholders, facilitators are needed. Stakeholders noted precedents and parallels, including:

- Centres of Expertise and cross-focussed groups such as ClimateXChange and Adaptation Scotland can facilitate.

- Parallels with food-borne disease: e.g. the UK-level joint working group on [Campylobacter](#), led by the Food Standards Agency includes farms, abattoirs, supermarkets, health bodies and Defra.
- The SNH-led [Our Natural Health Service](#), which builds on the Green Exercise Partnership, supported by the Scottish Government's environment and health portfolios. Other partners are NHS Health Scotland and Forestry Commission Scotland.

In Scotland we already have bodies working on cross-sectoral issues, such as those named above. This study suggests we need to build on this. Ensuring clear ownership can help ensure cross-sectoral impacts are captured and addressed, avoiding policy conflicts, unintended side effects and maladaptation.

Through engagement with stakeholders early in the process, the relevant policy areas can be mapped and integrated solutions sought.

This engagement also allows the identification of short-term, self-correcting issues, and longer-term plans that can 'lock-in' a long-term course of action. The latter is where cross-sectoral effort is most needed. Cross-sectoral decision making should focus where other motivating factors will not drive effective adaptation, or may lead to maladaptation.

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Annex 1: Workshop stakeholder input

Stakeholder post-workshop feedback

- I think the method has great merits. The suggested improvements to the methods will likely improve its validity, applicability across themes, and promote its uptake within the CC policy environment. I would certainly like to see this approach become the routine framework for cross-sector policy work. (My organisation) would certainly be very interested in the specific of Lyme disease management for policy.
- Really interesting workshop and subject matter. It's really good to be involved in discussions around topics that are very specific but infinitely complicated in terms of interdependencies. It would be good to see a greater range in types of stakeholders, although everyone today has had an interesting and unique perspective.
- Very interesting discussions dealing with strategies to effect change. Useful to consider this approach to other areas which may require adaptation in relation to climate change.
- Good mix of areas discussed and interesting to consider other sides of the fence on land management/tourism etc. Thought provoking discussions and lots learned to take back.
- First step in assessing x-sector Lyme issues. Forms basis for more.
- Helps identify which future research areas are most relevant to mitigation.
- Great to be brought together with other sectors I don't normally deal with.
- Very interesting and a good first step to cross sector working in this area.
- A few more specific and directed scenarios would have been good.
- Very interesting discussions and information. Seemed to be a good mix of people. I appreciated being able to talk about both methodologic and more specific risks. It seems that there are many more complicated trade-offs that I was previously aware of, which is important to know about.

Organisations attending the workshop

Visit Scotland

Scottish Land & Estates

University of Glasgow

Forest Research

Scottish Natural Heritage

Scottish Government

Moredun Institute

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