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Published online: 17 Oct 2018.

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Local government and urban forest governance: insights from Scotland

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ABSTRACT

While the benefits of urban forests (UFs) are well-researched, less is known about how to steer collective action for conserving and strengthening this resource, and particularly the role of local government. We address this knowledge gap through a study of urban forest governance in Scotland, United Kingdom. Applying a mixed-methods approach including semi-structured interviews, document analysis and surveys, covering 26 out of the total of 32 Scottish local authorities (LAs), we show that UF management by Scottish LAs is largely reactive. This can be explained by limited funding and knowledge of the resource, poor knowledge of the scale and state of the UF, fragmented management structures, and the tendency to perceive trees as a liability as opposed to an asset. However, some LAs successfully resist this trend through city officials acting as frontrunners within their organisations. They do so by championing activities such as investing in tools for socioeconomic valuation of the UF, pursuing grant funding, breaking down silos through organisational reorganisation, preparing city-level trees and woodland strategies, cross-sectoral partnership working and community engagement. Fundamental change, however, relies on the combination of these activities and therefore requires a whole-organisation commitment to UF sustainability across different domains relevant to predicting UF outcomes.

Introduction

The benefits of urban forests (UFs), here understood as "individual greenspace elements as part of an integral whole [and focusing on] tree stands as well as individual trees" (Konijnendijk et al. 2006, p. 94), have been widely reported (Roy et al. 2012). However, the means to steer the inclusion of these elements of urban greenspace in towns and cities, and deliver the benefits (i.e. urban forest governance (UFG)), are much less studied (Bentsen et al. 2010; Lawrence et al. 2013; Krajter Ostoić and Konijnendijk van den Bosch 2015). UFG is the result of the combined actions of a wide range of actors at different scales (e.g. local government, developers, non-profit organisations; Conway and Vander Vecht 2015). Their actions, in turn, are influenced by contextual factors, including environmental policy and planning frameworks, partnership working, available resources, and cultural processes within organisations and the wider society (Lawrence et al. 2013), all of which are relevant to the study of UFG. The relative lack of UFG research is problematic as natural resource governance is a critical predictor of urban sustainability (McCormick et al. 2013). The present study contributes to this field, using Scotland as a case study, by examining how governance arrangements influence UF management and decision-making by local authorities.

Urban forestry: why is it important?

The value of urban greenspaces for quality of life is now well-researched and documented (Gómez-Baggethun and Barton 2013; Haase et al. 2014). Many of those benefits associated with urban greenspaces can also be attributed more specifically to the UF (Tyrväinen et al. 2005; Nowak and Dwyer 2007; Jim and Chen 2009; Roy et al. 2012). The UF is key to urban sustainability (Duinker et al. 2015), firstly because it contributes to climate change adaptation through rainwater absorption, carbon sequestration, erosion control and regulating air temperatures (Tyrväinen et al. 2005; Nowak and Dwyer 2007; Jim and Chen 2009; Roy et al. 2012). In addition, it helps ameliorate health issues by filtering out air pollutants, and plays an important sociocultural role by providing opportunities for recreation, mental restoration, spiritual experiences and environmental education, and in embodying cultural heritage (Tyrväinen et al. 2005; Nowak and Dwyer 2007; Duinker et al. 2015).

On the other hand, UFs can also generate problems ranging from allergic reactions to pollen through to blocking light, signs and views, damage to man-made structures caused by tree roots, personal harm or damage to properties from falling trees or limbs, and messiness as a result of leaf litter, dropping sap or falling fruit (Tyrväinen 2001; Lohr et al. 2004; Nowak and Dwyer 2007). In addition, particular trees and woodland configurations may provoke fears about crime and abuse (Tyrväinen 2001; Jorgensen et al. 2002).

UFG is also important due to the significance of UF canopy cover. For example, a study on 20 cities in the United States (US) revealed that the average urban tree and shrub cover is 30% with some cities having over 50% canopy cover (Nowak

and Greenfield 2012). Average tree cover in Canadian cities is 26.1% (McGovern and Pasher 2016), and 39% in Australian (sub)urban areas (Jacobs et al. 2014). In England, a study of 17 towns and cities revealed a mean canopy cover of 18.1% with a range of 12%–23% (Doick et al. 2016). Within our study area of Scotland, no data on national UF cover are available. Data on urban greenspace cover show that it reaches about 40%, of which semi-natural greenspace, including woodlands, provides about 22% of Scotland's urban greenspace (Greenspace Scotland 2012). There are also data for some individual cities. Tree cover in the Scottish capital of Edinburgh is just over 17% (Hutchings et al. 2012), whilst in Glasgow, the largest Scottish city, it is 15% (Rumble et al. 2015).

The key role of local authorities in urban forest governance

Local authorities (LAs) have a central role in UFG, because of their statutory functions as service providers and urban planning authorities, and often also as public landowners. Given their strategic overview of the city and peri-urban regions, LAs are also well-placed to draw up UF strategies and management plans.

Studies of the role of LAs in delivering the UF have often focused on evaluating existing approaches to UF management against "good practice" standards. These are generally formulated to check for a planned, systematic and integrated approach to urban forestry (Britt and Johnston 2008; Stobbart and Johnston 2012). Many of these studies have been conducted in the US with a specific focus on evaluating state-level UF programmes. Programme elements typically include a tree ordinance (i.e. a decree outlining standards for tree planting, maintenance and protection), a tree advisory committee to oversee programme development and implementation, a tree inventory, and a management plan describing a vision, plan and costed actions (Ries et al. 2007). Findings indicate that only a limited number of towns and cities have completed all of the above programme elements (Elmendorf et al. 2003; Treiman and Gartner 2004; Kuhns et al. 2005; Ries et al. 2007). These papers provide recommendations to, for example, increase available grant funding, diversify income sources and increase provision of education and professional assistance. However, it is unclear whether these match the perceptions of LA staff responsible for UF management.

The US is not the only country in which UF management practices by LAs have been perceived as unsustainable and inadequate by experts. Funding constraints are a widely reported barrier to UF programmes in other countries in the Global North (Konijnendijk 2003; Britt and Johnston 2008; Stobbart and Johnston 2012; Driscoll et al. 2015; Kronenberg 2015), although Sweden is an exception to this rule (Randrup et al. 2017). Consequently, UF staff often do not have a comprehensive overview of trees and their condition (Pauleit et al. 2002; Britt and Johnston 2008; Stobbart and Johnston 2012; Kronenberg 2015). For example, in Toronto (Canada), UF staff reported limited knowledge of tree pests and diseases, and of planting strategies to minimise risk (Conway and Vander Vecht 2015). A lack of tree data is problematic, as an up-to-date and complete tree inventory is an important first step to planning and prioritising tree works (Stobbart and Johnston 2012). Lack of funding has also been linked to an experienced lack of professional assistance and education (Stevenson et al. 2008; Driscoll et al. 2015).

A New Zealand survey revealed that LAs experience difficulties in carrying out a significant percentage of tree works on a proactive basis and achieve a less-than-desired level of coordination during activities involving non-governmental actors, including citizens, businesses and public agencies (Stobbart and Johnston 2012). Using a similar survey approach in England, Britt and Johnston (2008) demonstrated that limited partnership working is also an issue in the UK. Engaging more with the private sector could be relevant as they can act as a source of knowledge regarding ecosystem services, and as investors (Young 2013). A lack of cooperation between compartmentalised LA departments is a threat to a robust and resilient UF as it leads to lower prioritisation of the UF vis-à-vis alternative land uses such as grey infrastructure development (Jim 2002).

Drivers of good practice in UF management

In addressing these barriers, the introduction of LA-level trees and woodland strategies can make a difference. They facilitate cross-sectoral partnership working and predict a strategic UF management approach (Nielsen et al. 2013; Kronenberg 2015). Inter-departmental communication is another important driver of effective UF management (Rines et al. 2010). European-wide research on success factors in green policy implementation revealed that the number of departments involved in urban green space management negatively predicts performance, unless a solid framework for internal collaboration is adopted (Baycan-Levent and Nijkamp 2009). Setting up dedicated urban greening authorities or hubs acting as meeting points for different LA departments directly or indirectly influencing UF development is arguably a step forward to arriving at a more coherent and efficient approach for dealing with cross-cutting issues (Jim 2002; Aylett 2013). Additionally, partnering with businesses and institutions outside of government can leverage innovation in urban forestry (Lawrence et al. 2013; Duinker et al. 2015), and provides opportunities to access alternative sources of knowledge and funding (Stobbart and Johnston 2012; Andersson et al. 2013; Atmiş 2016).

Organisations also have a role in encouraging individual staff to question current practice and, in doing so, develop innovative solutions that go beyond basic job requirements (Aylett 2013). Although offering great potential in helping to mainstream ecosystem services, urban foresters are not always supported in this role as a result of organisational inflexibility (Young 2013). This can be improved by the provision of open management structures (Janse and Konijnendijk 2007). Individual staff can also make a difference by acting as "frontrunners" within their organisations due to demonstrating competencies including creativity, social aptitude and leadership (Elmendorf et al. 2003; Brown et al. 2013).

Two drivers of proactive UF management that are increasingly being pursued by LAs are the use of socioeconomic UF

valuation tools and citizen participation. Socioeconomic valuation has the potential to transform the way authorities communicate about, monitor and manage UFs (Moffat 2016); it has been shown that LAs which understand a broad range of urban tree benefits increase efforts to protect this resource (Silvera Seamans 2013). Moreover, improved awareness of the socioeconomic benefits of UFs supports attempts at income leverage targeted at the private sector (e.g. Wolf 2003). Hands-on participation in UF care and maintenance can play a key role in accessing alternative sources of funding and manpower (Colding and Barthel 2013; Moffat 2016) and provides win-win opportunities as a result of an improved sense of place and quality of life experienced by citizens (Sipilä and Tyrväinen 2005; Janse and Konijnendijk 2007). Community outreach and education may be particularly effective in building support for UF management practices (Driscoll et al. 2015).

Theoretical framework to study UFG

Highlighting the need for a more comprehensive understanding and reporting of UFG, Lawrence et al. (2013) developed an analytical framework to support the systematic analysis and reporting of UFG (hereafter called: UFG framework). The UFG framework was developed and tested through a process which combined theoretical and empirical elements. Definitions of "governance" were reviewed to propose a basic structure that accommodates issues including formal and informal institutions, rules, mechanisms and processes of collective decision-making, and interactions with the environment, while also acknowledging the importance and subjectivity of notions of power, knowledge, scale and process. An iterative empirical approach was used to elaborate the framework, settling on five main dimensions: context (e.g. size of population and forest catchments), institutional framework (e.g. relevant policies and regulations), actors and coalitions (e.g. primary stakeholders and power dynamics), resources (e.g. knowledge and funding), and processes (e.g. discourse and citizen participation), as shown in Table 4.

Within this UFG framework, local government, whether municipalities or local authorities as they are known in the UK, plays a prominent role, but there are of course many other stakeholders. The UFG framework was designed to analyse UFG holistically, but it can also be used to explore the role of particular components, in this case local government. It can direct researchers towards an understanding of the ways in which political, organisational and established power relationships interact with broader societal processes to influence the sustainability of UF management. It can be used as a basis for understanding the underlying dynamic explaining pinch points and for identifying opportunities for positive change.

We therefore take the UFG framework as a starting point to explore the role of LAs in UFG in Scotland through the following questions:

(1) How do LAs in Scotland vary in their approaches to UFG?
(2) Which actors and processes affect approaches to urban forestry in Scotland?

(3) What are the UFG challenges and opportunities for Scottish LAs?

Material and methods

The study used a mixed methods approach, designed initially to respond to a request for information to help develop policy on urban tree management. Themes were agreed with a steering group comprising policy advisors, arboriculturalists and tree officers. Data were then collected through three components:

(1) nine semi-structured interviews with representatives of several Scottish LAs;
(2) analysis of documents on UF management (e.g. strategies and management plans) found online and received via interviewees;
(3) a short survey distributed to all 32 Scottish LAs.

Appendix A provides an overview of the data that each LA provided.

Each of the nine semi-structured interviews focused on one or more specific city or town(s) within a local authority. These were selected in consultation with a steering group comprising representatives of Forestry Commission Scotland, Arboricultural Association and several Scottish local authorities to provide a representative sample of town sizes and ages of tree stock. Interviews were held with tree officers and/or other staff with responsibility for tree management. We included the following themes: current state of the municipal forest; drivers of and barriers to good practice in UF; statutory requirements; urban tree strategy and policies; financial and knowledge resources; urban tree inventory and inspection regime; data management; and participation. Interviews were completed between July 2013 and January 2014, and subsequently transcribed for thematic analysis.

The document analysis served to check for availability of strategic UF documents and additional information on legislation, policies and guidance informing current practice as well as funding streams. Relevant information on these variables was recorded in a spreadsheet.

The survey was sent electronically to relevant contacts identified within each LA. Relevant contacts were identified by consulting with members of the steering group and Forestry Commission, undertaking web searches, and making telephone calls to local authorities. Survey contacts were asked to consult with colleagues, if required, in providing their responses. The surveys focused on collecting some easy-to-quantify information on available tree/woodland (policy) documents, resources, available UF data, and community involvement practices. To maximise response rate, the number of questions in the survey was restricted. To ease comparisons of data between Scotland and England, questions on similar themes used the same wording as those in the previous survey in England (Britt and Johnston 2008). The survey was piloted by three local authority staff, leading to a few final amendments. A total of 22 LAs (69%) returned the survey. Of these, 15 (47%) completed all items, including

the three largest cities (Glasgow, Edinburgh and Aberdeen). Combined, the interviews and surveys provide data about (urban) tree management practice in 26 out of 32 Scottish LAs (81%).

Following the method established by Britt and Johnston (2008) in England, elements of the survey data were checked against demographic data, using variables derived from the National Statistics Urban Rural Classification 2011–2012 Population Tables (Scottish Government 2012), which classifies population data by six urban/rural variables, for each of the 32 Scottish local authorities. Given our focus on the UF, two variables were used from this dataset: population size and urban weighting. The latter variable was computed by adding up the population percentages listed in the "large urban", "other urban", "accessible small towns" and "remote small towns" columns, and dividing this by the total population. The resulting index indicates the proportion of the total population living in a settlement with 3,000 or more inhabitants for each of the local authorities. Following Britt and Johnston (2008), we relied on frequency and descriptive data – count, mean and standard deviation – for the analysis of the survey data. In addition, we carried out statistical testing using Spearman's correlations to check for relationships between variables of interest.

Our combined quantitative and qualitative findings were then analysed and coded according to the dimensions used in the UFG framework (Lawrence et al. 2013).

Results

Our results section describes our findings according to the dimensions of the UFG framework (Lawrence et al. 2013). In the following sections we describe and analyse the dimensions in more detail, explore the range of findings as well as influences on that range.

Institutional framework

Policies

The starting point of all public and private woodland and forest management in Scotland is the Scottish Forestry Strategy (Scottish Executive 2006). It has a core focus on sustainable development which it seeks to promote in seven key themes ranging from timber resource management and business development to public access and health. Implementation is based on a mix of policy tools including provision of information, regulation, incentives, research and direct investment. For example, the Woods In and Around Towns (WIAT) programme provides funding and support in regenerating UFs, which has helped to raise their profile. Forest policy has also prompted the development of planning guidance in documents such as The Scottish Government's Rationale for Woodland Expansion (Forestry Commission Scotland 2009), the Climate Change Programme (Forestry Commission Scotland 2013) and "The Right Tree in the Right Place" (Forestry Commission Scotland 2010), which serve to deliver the ambitions outlined in the Scottish Forestry Strategy.

Interviews highlighted a particularly strong influence of this latter document on urban forestry, which is through the provision of guidance to LAs on preparing a local trees and woodland strategy. A local trees and woodlands strategy, prepared by 41% of Scottish LAs and in development by 23% of LAs, translates national policy into a local vision and objectives for the urban forest and prioritises areas for different types of management activities. In some cases this also incorporated advice provided by relevant networks and regulatory and professional bodies such as National Tree Safety Group, Health & Safety Executive British Standards Institution, Arboricultural Association, and International Society of Arboriculture.

At a local level, the trees and woodland strategy was considered an important medium for communicating the role of the UF in meeting diverse urban challenges such as biodiversity conservation, health and well-being and stormwater management to stakeholders, including politicians. Therefore, it was seen as contributing to collaborative working between municipal departments and pooling resources, explaining the benefits of the UF to the wider public, and ultimately encouraging a more proactive tree management approach.

Trees and woodland strategies were often accompanied by woodland management plans including action plans for individual woodlands. Twelve LAs (54%) indicated that they have a management plan. The number of management plans varied widely from one to 38 plans per LA.

Planning and regulations

Planning policy was also considered relevant to UFG. The Town and Country Planning (Scotland) Act 1997, as amended by the Planning etc. (Scotland) Act 2006, requires LAs to prepare, and regularly update, a local development plan for their area, which includes policies on the planning and protection of the UF. There is a need for LAs to consult Scottish Planning Policy (2010) when preparing their local development plan. This specifies that LAs should restrict the removal of existing woodlands and strive to identify and protect trees with high conservation value. In addition, it encourages LAs to take the initiative in creating new woodlands as part of new developments and in strategically improving habitat networks. Interviewees often mentioned the Central Scotland Green Network Trust (CSGNT) – an independent charity part-funded by the government – as a valuable source of advice and funding.

Another important planning document is the Planning Advice Note (PAN) 65, part of Scottish Planning Policy, which prompts LAs to prepare an Open Space Strategy. This serves to ensure a strategic approach to developing and (re-)purposing public outdoor environments, including wooded landscapes. It typically includes action plans at neighbourhood level as well as an overview of greenspace funding opportunities.

Legislation creates statutory requirements for LAs, of which respondents highlighted the following:

- A duty of care under the Occupiers Liability (Scotland) Act 1960, which requires LAs to take reasonable steps to ensure the safety of those passing by trees. This Act does

not require LAs to guarantee tree safety nor to survey each and every tree in their area;

- A duty, whenever appropriate, to apply Tree Preservation Orders (TPOs) to trees with high amenity value and/or cultural or historical significance, under the Town and Country Planning (Scotland) Act 1997, as amended by the Planning etc. (Scotland) Act 2006.

The duty of care was considered a particularly important driver for urban tree management. Several interviewees referred to a case in which Birmingham City Council had been successfully prosecuted by the Health and Safety Executive over a mature tree which fell in a storm in December 1999, fatally injuring three people in their cars. The Council was fined and served notice to improve its systems to provide suitable and sufficient routine inspection, including identifying all trees and woodland, procure competent advisors as necessary, and carry out and record necessary remedial actions (BBC 2002; Hazell 2014).

The interviews and document analysis revealed that LAs also work to other statutory requirements regarding the improvement of biodiversity conservation (Nature Conservation (Scotland) Act 2004), cutting carbon emissions, acting sustainably and building in resilience to future climatic conditions (Climate Change (Scotland) Act 2009), and minimising flood risk (Flood Risk Management (Scotland) Act 2009). Figure 1 provides an overview of all relevant policies and instruments.

Ownership

Scottish LAs are formally only responsible for the management of the urban forest on public land, and do not intervene in privately owned assets unless these are situated in Conservation Areas or are subject to a TPO. Most of the LAs could provide an estimate of the total area of land covered by trees and woodland in urban areas but only one LA responding to the survey could do so on the basis of a full survey of publicly-owned trees and woodlands. Only out of nine LAs could provide a data-informed estimate of privately owned urban forest cover.

Access and use rights

In Scotland, responsible public access to most land (excluding "buildings and their immediate surroundings; houses and their gardens, and most land where crops are growing") for recreational and educational purposes is guaranteed by the Land Reform (Scotland) Act of 2003 (SNH 2018). LAs have a duty to prepare a Core Paths Plan and to keep routes freely accessible under the Scottish Outdoor Access Code.
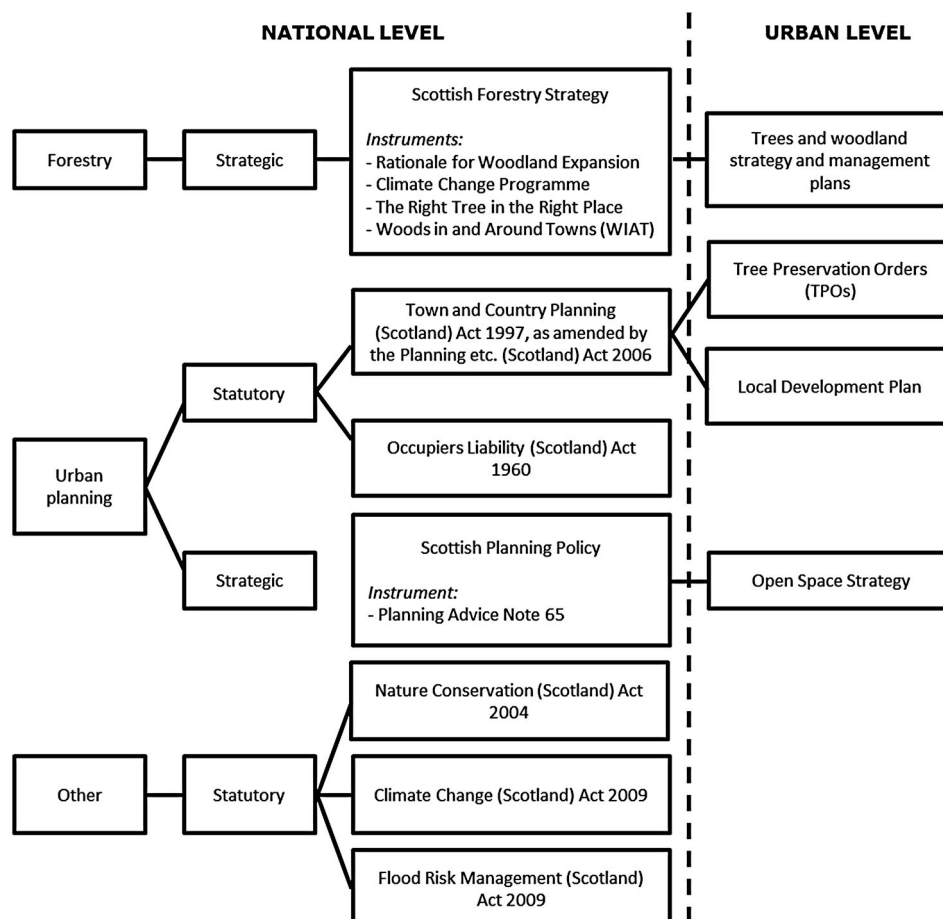

Figure 1. Overview of relevant policies and instruments to urban forest governance in Scotland at national level and their translation into policies and instruments at the urban level.

Actors and coalitions

Primary stakeholders

LA staff who manage processes related to the UF were located mainly in the environmental services and planning departments. The former is concerned with the operational aspects of UF management while the latter is responsible for tree preservation orders, tree-related enquiries and UF provision in new urban developments. In practice, there was often an overlap between duties performed by environmental services and by planning. For example, tree officers in environmental services departments may advise on tree health and the safety of works involving trees by planning departments. They were also sometimes invited to comment on planning applications and new site designations. Tree officers in turn sometimes asked colleagues in planning for advice on the tree strategy, the socioeconomic value of trees and site-specific statutory requirements.

Other stakeholders

Other LA departments often also carry management responsibilities for tree assets. For example, roadside trees may be owned by a separate Roads Department; the Housing Department manages the trees in housing schemes, while the Social Work and Education Departments manage the trees around care units and school grounds, respectively. Effective communication and inter-departmental collaboration were perceived as key to strategic UF management, and LAs varied in the degree to which they achieved this.

The LA's organisational structure can play an important role to help overcome organisational silos resulting in staff making decisions based on inadequate information. To illustrate, one LA was very pleased with an organisational model in which the same staff members could work both on strategic and operational matters. In addition, staff only managed those assets for which they had the right skills and expertise, regardless of departmental asset "ownership". For example, the environmental services section was responsible for all public trees and green features in town, regardless of location in playgrounds, housing estates, cemeteries or parks. This organisational structure had also facilitated effective communication between staff members because it created fluid roles and status differences were experienced as less profound.

External stakeholders who affect the LA's role in UFG included non-governmental organisations and professional bodies. These stakeholders lobbied national government, provided professional guidance (see section on "Policies"), and organised training and knowledge exchange events (e.g. CSGNT, see section on "Planning and regulations"). Contractors and citizens, often organised in community groups, have also influenced LA management of the UF to a smaller extent.

Partnerships

Several LAs had set up coalitions with environmental NGOs and government agencies to improve access, amenity value and conservation. For example, Dundee Trees and Woods in Greenspace (TWIG) is a network involving Dundee City Council, Forestry Commission Scotland, Scottish Natural Heritage and Greenspace Scotland, which is aimed at achieving a coordinated approach to UF management. Likewise, the Scottish Tree Officer Group was generally considered a helpful platform for knowledge exchange and advice by tree officers.

Power analysis

As highlighted previously, the national government, government agencies, professional bodies and environmental NGOs have a powerful influence over urban forestry through setting regulation, providing policy instruments such as the WIAT funding, strategic policy documents, engaging in lobbying and providing professional guidance and knowledge exchange through high-profile partnerships.

Internally, senior management and councillors were key to urban forestry outcomes. They set budgets and decide upon the way LAs organise themselves around managing the UF. Some interviews revealed a disparity in priorities between tree officers (along with supporting professional bodies, government agencies and NGOs), who typically favour a proactive UF management approach, and LA senior management, although this was strongly dependent on personalities and/ or priorities:

> I've always felt supported by senior management. I think there have only been, in the time I've been here, two or three incidents or issues that we've not agreed on and I've had to do something that I wasn't happy with. Whereas in my last incarnation that happened regularly, … .where one of our senior executives basically overturned decisions regularly to keep the politicians happy. [Interview 6]

Individual tree officer efforts sometimes played powerful roles through lobbying and fundraising. They could also influence the prioritisation of urban forestry vis-à-vis domains such as housing, schools and social services by taking the initiative for new regional UF partnerships involving NGOs and government agencies, and by taking the lead in preparing trees and woodland strategies.

Resources

Funding

All Scottish LAs received core funding from national government. The revenue budget also included income from council tax, business rates and service fees. To compensate for decreasing government income, LAs were increasingly relying on external funding schemes. These included competitive government-funded schemes, other funding bodies (e.g. Heritage Lottery Fund) and business contributions (e.g. Landfill Communities Trust). Operational staff sometimes generated income by offering their services on a chargeable basis to other departments and external organisations. Community groups also sometimes contributed to UF management on public land by raising their own funds.

The majority of LAs (60%) reported that they have been working with a stable tree management budget over the past five years (Table 1), but on average and corrected for inflation, LAs' tree management budgets had decreased slightly (−5%) over this period.

Table 1. Change in local authority (LA) trees and woodland budgets over the past five years (controlled for inflation).

Direction of change	Number of LAs (% of LAs responding)	Mean % change
Decrease	4 (27%)	−21%
Static	9 (60%)	
Increase	2 (13%)	+27%
Total	**15 (100%)**	−5%

Table 2. Budget per head of local authority (LA) population for management of public trees and woodlands.

Budget p/head (£)	No. of LAs (% of LAs responding)
≤ 0.50	4 (27%)
>0.50–1.00	4 (27%)
>1.00–1.50	3 (20%)
>1.50–2.00	2 (13%)
>2.00–2.50	0
>2.50–3.00	2 (13%)
Total	**15 (100%)**

Resources were generally experienced as inadequate. The survey showed that LA expenditure on tree management averaged £1.18 per head of population in the 2014–15 financial year. There was a wide range of budget allocations; about a quarter of LAs spent £0.50 or less per head of population, whilst two of them spent over £2.50 (Table 2).

The number of staff undertaking activities related to tree management also varied widely between LAs, from less than 0.5 full time equivalent (FTE) to over 10 FTE (Figure 2). On average, 35% of LAs' (urban) forest budget was spent on contractors with one in four LAs outsourcing over 70% of their budget (Figure 3). This could be explained by differences between LAs in size and tree density:

> When you get three or four trees to do in a year, it's not worth having a forestry department. In some of the other areas, they only do it [forestry] part-time for three, four months through the winter. [Interview 4]

Both budget per head of population ($r_S = 0.55$, $p = 0.02$, 1-tailed) and number of UF staff ($r_S = 0.65$, $p = 0.001$, 1-tailed) are correlated with urban weighting. In other words, LAs with a higher number of citizens living in towns and cities spent more on trees and woodland management, and allocated proportionately more staff time.

Knowledge and information

The survey showed that nearly half of all respondents with key responsibility for the LAs' UF had a qualification with QCF-level 5 – broadly equating to a Bachelor's degree – or higher in the field(s) of arboriculture and/or forestry. Respondents indicated a need for more training and knowledge exchange to keep their knowledge and skills up-to-date:

> Obviously coming into arboriculture and the courses that I then had to undertake and speaking to people, you get a tremendous amount of knowledge […] I just think these things are now diminished, diminished greatly, and it's such a shame because it's now looked upon [by senior management] as "being a day out". [Interview 1]

Tree officers frequently noted that an up-to-date tree inventory is "an essential part of good arboriculture management", providing "the baseline information for any asset management plan". However, inventories were often lacking or incomplete, leading to oversights in management.

Data quality and completeness were perceived to be an issue by some LA representatives, either because data had been gathered by amateurs or because crucial information on e.g. tree condition had not been recorded. Very few LAs had carried out full surveys of their trees across different categories (Table 3). This was experienced as frustrating:

> We're looking to see if there's any external funding to help us record up to two million trees in the city, at the present time we've only got about 7,000 on the computer. [Interview 3]

As a result of resource constraints, only about one fifth of LAs spent over 70% of time on scheduled tree maintenance and nearly half were undertaking less than 10% of their tree works on a proactive basis (Figure 4).

Most LAs had made their UF data publicly accessible. TPO data were most commonly available, shared by three quarters
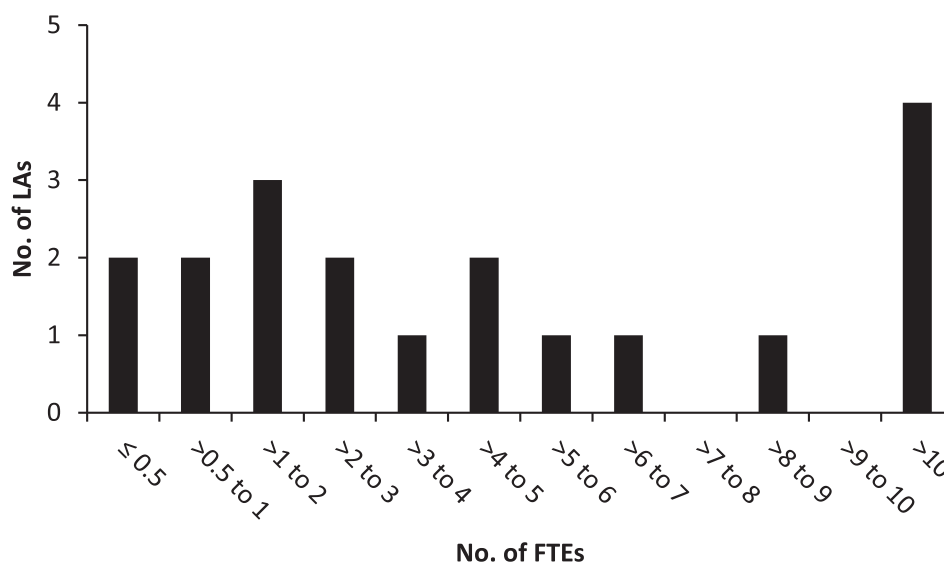
Figure 2. Number of total officer full time equivalents (FTEs) allocated to the management of (urban) forest for each local authority (LA).
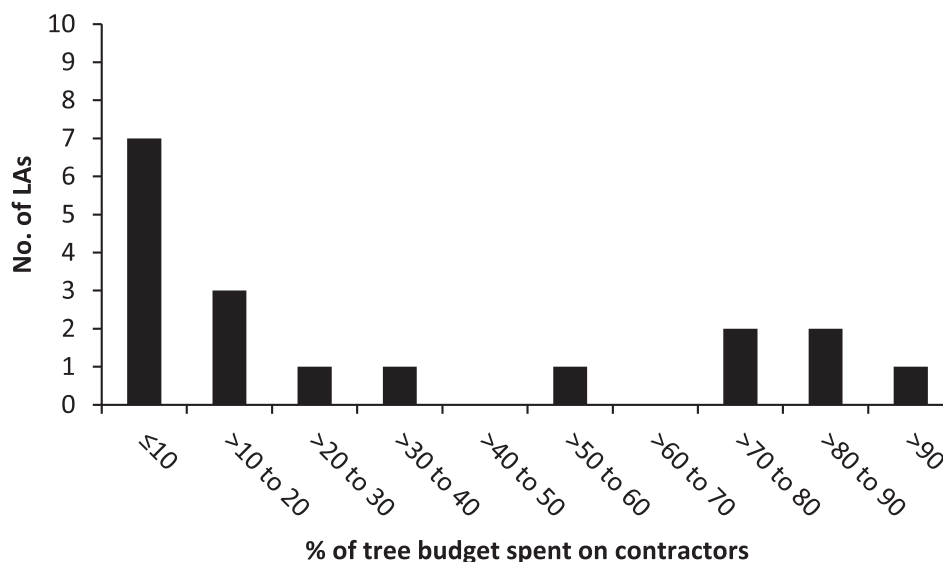
Figure 3. Percentage of total tree budget spent on contractors (incl. consultants) by different local authorities (LAs).

Table 3. Number of local authorities (LAs) that had carried out tree surveying of different categories of trees and woodlands, split by type of survey, in the past five years (% of LAs responding).

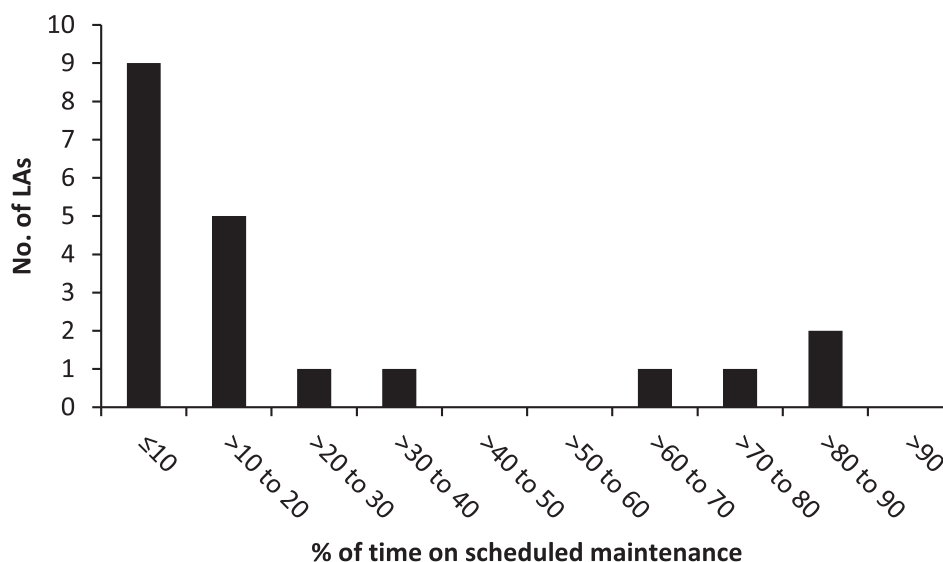|	Street trees	Woodland	Public open spaces	TPOs	Education premises
Full survey	4 (20%)	3 (15%)	3 (15%)	2 (11%)	5 (28%)
Partial survey	10 (50%)	10 (50%)	14 (70%)	6 (32%)	4 (22%)
Sample survey	2 (10%)	2 (10%)	0	1 (5%)	0
No survey	4 (20%)	5 (25%)	3 (15%)	10 (53%)	9 (50%)
Total	**20 (100%)**	**20 (100%)**	**20 (100%)**	**19 (100%)**	**18 (100%)**

Note: TPO = Tree Preservation Order.

Figure 4. Percentage of maintenance work on the (urban) forest, in terms of required time, that was scheduled (as opposed to "on demand") for each local authority (LA) at the time of surveying.

of all LAs, in most instances through the LA's website. Survey information was publicly available in a quarter of all cases; usually through contacting a member of staff. A small number of LAs also shared data on heritage trees on their website.

One out of the nine interviewed Scottish LAs was anticipating to carry out an i-Tree survey, which is tool for socioeconomic tree valuation.

Delivery mechanisms

The main UF delivery mechanisms are regulation, policy instruments and external funding, as listed previously. Organisational structure and partnership working were also broadly considered to be important, as outlined in the section on "Actors and coalitions". Another delivery mechanism – citizen participation – is described in the next section.

Table 4. The key findings described with the urban forest governance framework.

(Sub)component	Summary
Type	Programme
Description	Local authority UF management programme
Spatial scale	Local authorities
CONTEXT	
Environmental resource	Urban and peri-urban trees and woodlands; the exact size of the resource was unknown in most cases
Catchment population	Local authority population; varying from 21,700 to 606,000.
INSTITUTIONAL FRAMEWORK	
Policies	The Scottish Forestry Strategy (2006) and associated policy tools. Most notably the Woods In and Around Towns programme earmarking funding and support for UFs and the "The Right Tree in the Right Place" policy guidance encouraging the providing advice on preparing trees and woodland strategies at local authority level.
Planning and regulations	The Town and Country Planning (Scotland) Act 1997, as amended by the Planning etc. (Scotland) Act 2006 informing preparation of Local Development Plan. This takes into account principles relevant to forestry of the National Planning Framework 2,. The National Planning Framework 2 also introduces the Central Scotland Green Network programme promoting and funding UFs in the Central Belt. Other relevant planning policy and regulation includes Scottish Planning Policy providing principles on woodland creation and conservation and informing preparation of Open Space Strategy with key role in setting UF budgets. There are also statutory requirements, most notably a Duty of Care and a Duty to make Tree Preservation Orders.
Ownership	A significant portion of the UF is owned and managed by LAs, but exact figures were lacking in most cases. Other prominent landowners include environmental NGOs and private parties.
Access and use rights	Scotland has a public right of way as guaranteed by the Land Reform (Scotland) Act
ACTORS AND COALITIONS	
Primary stakeholders	Scottish Government; the Environmental Services (or Land/Neighbourhood Services) and (Development &) Planning LA departments
Other stakeholders	Other tree-owning LA departments (e.g. Housing, Roads); government agencies, professional bodies and NGOs influencing policy and providing guidance; community groups and contractors are involved in plan development or implementation
Partnerships	Some LAs have set up city-specific networks involving external organisations and urban foresters can regularly meet in the Scottish tree officer group
Power analysis	Externally, national government, government agencies, professional bodies and environmental NGO are powerful with decisions influenced to various extents by LAs. Internally, senior management and councillors make most decisions with scope for lobbying by individual staff members taking initiative.
RESOURCES	
Funding	With a mean budget of £231,962, expenditure on tree management per head of population is £1.18. There is high variability between LAs in budget per head of population. Budgets had declined in a quarter of all LAs over the past five years with a few positive exceptions. Capital is mainly provided through core funding, government and other types of grants, staff outsourcing and community fundraising.
Knowledge and information	Nearly half of key LA urban forestry staff have a qualification with QCF-level 5 or higher; there is limited scope for learning and development. Very few LAs have a complete picture of the (condition of their) tree stock. Survey information is generally not publicly accessible without contacting a member of staff. There is a trend for assessing the socioeconomic value of the UF
Delivery mechanisms	Legislation, policy guidance and funding schemes. Citizen participation plays an increasingly important role.
PROCESSES	
Discourses	Urban trees are perceived as dangerous and declining in quality due to disinvestment. However, people are also motivated to engage in UF activities to enjoy and support their benefits.
Participation	The majority of LAs involve citizens in at least some aspects of UF creation, maintenance and decision-making. Consulting citizens on plans and citizen involvement in care and maintenance were most frequently reported.
Monitoring and evaluation	Management plans and UF strategies are typically evaluated and updated every 5–10 years. Tree inspection regimes vary between LAs but very few regularly inspect all trees. Half of all LAs indicated to use a computerised tree management system for monitoring and evaluation.

Processes

Discourses

Tree officers encountered different kinds of opinions about UF in the course of their interactions with the public. First, urban trees were sometimes portrayed as dangerous or as a nuisance for issues such as blocked sunlight. Second, and related to the previous point, LAs were sometimes confronted with citizens' self-organising maintenance activities out of dissatisfaction with the standard of UF management:

> We have the Friends of Belleisle. […] Funnily enough, it was a response [by the general public] to the lack of maintenance and management of the park by the local authority, them saying "enough is enough". [Interview 1]

Participation

All but one of the surveyed LAs reported that they facilitate one or more types of community involvement in UF management, and that these can improve the social benefit of their activities and help to access additional funding. LAs with higher population sizes and tree management budgets facilitated a higher number of community engagement activities ($r_S = 0.71$, $p = 0.001$, 1-tailed and $r_S = 0.61$, $p = 0.008$, 1-tailed, respectively). Activities ranged from improving accessibility (e.g. constructing paths and benches) through to providing amenities (e.g. installing art works and visitor information signs), supporting woodland biodiversity (e.g. installing bird/bat boxes) and political lobbying.

Respondents indicated that working with community groups can be quite resource-demanding. Yet, community groups may also bid for funding and provide in-kind contributions to the UF, and therefore compensated to some extent for cuts to LA funding.

The majority of LAs involved community groups in consultation, and in care and maintenance of urban trees. Over half of LAs engaged in knowledge sharing with citizens and shared decision-making, while a similar proportion actively facilitated community-led decision-making. Data collection by the public (i.e. citizen science) was much less common; a tree warden (or similar) scheme was in place in less than a fifth of all LAs, which was due to concerns about resourcing follow-up activity.

Monitoring and evaluation

Only a few LAs had inspected all trees within any of the following categories over the past five years: street trees, woodland trees and trees in public open spaces. Inspection regimes were particularly poor for trees under a TPO, and trees on educational premises; in fact most LAs had not carried out any inspections of these categories.

Half of all LAs employed a computerised tree management system in order to store tree-specific data such as a basic description, location, condition, management history, enquiries and TPO-status. Half of these used an off-the-shelf system, one fifth a bespoke system and nearly one third a system developed in-house. Respondents cited improved efficiency of dealing with public enquiries around tree condition and management procedures, and improved data sharing between departments, as benefits.

Discussion

In the results section we have described Scottish LAs' approaches to urban forestry and identified key challenges responsible for many of the perceived sticking points in UFG. We provide an overview and summary of findings in Table 4. In this section, we reflect upon the findings for Scotland within the wider UFG research context and identify opportunities for policy and practice to improve on the status quo. We describe the influence of different governance processes on UF outcomes, touching upon innovative approaches employed by some LAs to improve the standard of their UF management.

Key features of Scottish local authorities' approach to urban forest governance

Little was known based on previous studies regarding the influence of *policies at different levels* on UF management. We found that, amongst regulatory instruments, the impact of the duty of care was relatively strong compared to relevant duties related to biodiversity conservation and climate change. Such inertia in responding to climate change is a common phenomenon in spatial planning, owing to uncertainty around impacts of climate change and timing of tangible changes beyond the typical planning horizons (Matthews et al. 2015). The strong emphasis placed on the duty of care partially accounted for most LAs prioritising responses to enquiries and complaints over a more proactive tree management approach.

Going beyond national regulation, this study also demonstrated that forestry-specific policy frameworks have a strong influence on UF decision-making and investment by LAs, for example by encouraging LAs to develop a trees and woodland strategy. The development of a strategic approach to UF by LAs was important in countering reactive UF, as it promotes inter-departmental communication around cross-cutting themes and pooling of resources, and provides clarity and consistency in outgoing messages to managers, landowners, funders and the general public. Much can be won in this regard as fewer than half of LAs had developed a trees and woodland strategy, although this compares

favourably to known figures for countries such as Denmark at 20% (Nielsen et al. 2013) and England at 28% (Britt and Johnston 2008).

Regarding *communication, partnership working and the role of frontrunners*, the present findings were much in line with those previously reported. UF management was typically the joint responsibility of several departments in Scottish LAs. We found that this can lead to knowledge fragmentation and internal disagreement, and ultimately to decisions affecting the UF that are based on inadequate information (also see Jim 2002). Those responsible for different aspects of UF in LAs often had an incomplete picture of the resource that they are managing. Our findings suggest that the observed fragmentation could be a consequence of austerity and diminished importance of the UF; revenue from land-sale for property development is making up an increasingly large share of LA budgets.

In order to achieve a consistent and broadly-supported approach between LA departments supporting activities such as tree planting in new developments, administering TPOs and translating policy into management practice, LAs sometimes actively promoted interdepartmental collaboration. For example, by introducing a policy enabling staff to work across strategic and operational domains depending on where their skills and expertise is most relevant at the time. This approach was effective in overcoming the compartmentalisation that can be detrimental to UFs, which are a cross-cutting issue but not always a priority (Jim 2002).

Committed individual staff members managed to challenge established UF practices through e.g. regional partnership working and proactive UF strategy development. Those engaged in pursuing partnership working with different sectors did so in order to gain new knowledge, professional support and improved access to external funding. Despite this, particular categories of stakeholders, such as businesses (other than contractors) and private landowners, remain underrepresented in established UFG coalitions.

Restrictions to *funding, knowledge and human capital* are often cited as influencing UF outcomes (e.g. Britt and Johnston 2008) and this study is no exception. Scottish LAs' financial resources for UF management were perceived as inadequate. Funding applications targeting government UF programmes partially compensated for decreasing levels of core funding. However, one-off grants did not cater for systematic improvements to the management of the UF as a whole. Funding constraints limited the frequency of UF surveying and inspections; very few LAs had a complete picture of their UF and its condition.

We found one LA which was experimenting with i-Tree as a tool for socioeconomic urban forest valuation, and this was seen as a promising way forward in making the case for higher urban forest investment internally. However, i-Tree and similar tools should not be regarded as a panacea rendering other types of UF knowledge obsolete, given the importance of local context in judging suitability of trees and species. Moreover, not all UF value can actually be easily monetised (Moffat 2016).

An interesting finding is that relatively urbanised LAs invested relatively more in trees and woodland management,

and concomitant staff base, per head of population. An explanation could be that these LAs have a high concentration of people and built infrastructure and therefore attribute relatively high value to ecosystem services such as air filtration, stormwater capture and recreation. In addition, there could be more lobby activity by environmental NGOs in these LAs (Silvera Seamans 2013).

Although nearly half of LAs had at least one staff member with a Bachelor's degree or higher in arboriculture and/or forestry, the interviews revealed a need for more regular training and engagement with relevant professional societies in order to improve standards of practice. Although opportunities for such training are provided by relevant bodies, a lack of time and money prevented many LA staff from making regular use of these.

The *public discourse and citizen engagement* has received little attention in previous research on UFG. In the present case, we found that the discourse often focused on the declining UF quality or the related danger posed by falling trees close to houses, roads or paths. Indeed, perceived risk is an important driver of UF management in Scotland (Moffat 2015). Sentiments may have also been influenced by media coverage of incidents to which public opinion on UF management has high sensitivity (Stobbart and Johnston 2012). Yet, we also found that citizens, spurred on by institutionalised health programmes, were prepared to get actively engaged in woodland activities and make the most of their value for human health.

In agreement with the broader European trend for increased co-governance arrangements in urban greenspace management (Molin and Konijnendijk van den Bosch 2014; Buijs et al. 2016), we found that many Scottish LAs facilitated public participation in UFs, varying from public consultations to supporting community woodland groups. Although some tree officers expressed concerns about the considerable expenditure of resources towards supervision and follow-up required for co-management, investing in this way provides indirect pay offs by reducing the number of enquiries and complaints (Sipilä and Tyrväinen 2005), while also prompting operational cost savings.

Community forestry in Scotland is more often associated with rural than urban contexts, or where urban, has tended to take the approach of providing woodlands *for* local people rather than transferring management responsibility *to* local communities (Lawrence et al. 2009, 2014). It was interesting therefore to note a number of urban community woodlands where local residents have a share in management decisions.

Current threats to the public urban forest in Scotland

The overall picture emerging from this study on UFG with a focus on Scottish LAs is that management is largely reactive rather than proactive. The predominant management approach means that UF management is not sustainable in many places. For example, we observed a rather *laissez-faire* approach to tree pest and disease management. Based on the interviews, very few Scottish LAs engage in contingency planning in preparation for a potential outbreak. The risk is

further increased by the trend for reduced tree inspections and qualified staff members. This is despite climate change increasing susceptibility to tree pests and diseases (Tubby and Webber 2010), an increase in the rate and regularity of these becoming established in the UK (Forestry Commission 2011), previous experience with (ineffective biosecurity measures to control) tree diseases (e.g. Dutch elm disease) decimating millions of urban trees (Brasier 1996), and broad societal support for tree health management (Fuller et al. 2016).

The conservation of heritage trees is also under threat. In particular the lack of monitoring for pests and diseases, insufficient protection against urban expansion, and limited planting and protection of young trees which could become the "heritage trees of the future". This is problematic as they have high biodiversity and act as highly valued landmarks carrying shared cultural values providing a sense of place (Lindenmayer et al. 2014).

Conclusion

We started this paper by arguing that to deepen our understanding of UFG, we need more detailed studies of the complex realities of urban forest management, particularly from the perspective of a key but understudied actor, local government. This study contributes to that by applying a holistic, mixed-method approach to studying LAs in Scotland in relation to the UF. The main conclusion, that UF management by Scottish LAs is reactive, corresponds with previous findings in Great Britain (Britt and Johnston 2008; Moffat 2015), Europe (Pauleit et al. 2002; Kronenberg 2015), and North America (Driscoll et al. 2015; Duinker et al. 2015). However, the main contribution of this study consists of the insights provided into the interplay of actors, institutions, resources and societal processes explaining this outcome, and into promising pathways towards proactive UF management, which relies on positive change across multiple governance components.

It is a concern for sustainability that UF management by LAs is largely reactive, lacking vision-led planning and investment. The more proactive approach is most clearly constrained by:

- limited funding and a shift to project-based grant funding;
- poor knowledge of the scale and state of the UF;
- fragmented management structures limiting knowledge exchange and establishing a comprehensive picture of UF benefits; and
- priority given to meeting the duty of care rather than other (climate change and conservation) duties, partly owing to a legal precedent in which an LA was convicted for negligence in ensuring tree safety.

Nevertheless, positive exceptions demonstrate opportunities to challenge the status quo. We found opportunities for more proactive management within current constraints in the adoption of an UF strategy at the LA or city level, implementation of state-of-the-art data management tools, successful pursuit of grant funding, organisational reform,

community engagement, transdisciplinary partnership working and assessments of the socioeconomic value of UF amenities.

To build on these opportunities, LAs rely on the knowledge, motivation and commitment of councillors, senior staff and those responsible for management of the UF. National government can also play a key role through core funding for LAs, legislative instruments, and the provision of national policy and challenge funds, especially in the domains of public participation and UF strategy development. This suggests a need, at both local and national government levels, for transformation towards a whole-organisation commitment to addressing UF challenges.

A pivotal action that LAs could take towards this end is to engage in an assessment of the socioeconomic value of the UF, particularly in terms of human health and well-being. Highlighting the socioeconomic value of trees, as is has been done in Glasgow using i-Tree, could contribute to the pooling of resources between different departments and provides a much stronger case when applying for external funding or seeking public-private partnerships. A better understanding of socioeconomic benefits could in the medium-long term also influence government funds made available to support UF, and therefore clearly provides win-win opportunities. Another way forward would be for Scottish LAs to support greater community engagement and partnership working with UF benefactors who are not yet broadly engaged such as the finance sector and homeowners. Aside from offering the potential of bringing in additional investment and volunteer labour, engaging non-governmental actors can also be instrumental to the timely identification and reporting of tree-related issues such as pests and diseases. Moreover, collaborative planning and development increases the socioeconomic value of the urban forest, as it provides a better fit with user needs.

In summary, actions aimed at a more integrated understanding, assessment and co-creation of UF values emerge as most promising pathways to bring about a systemic shift to a new and broadly shared sense of responsibility for the stewardship of the UF. These are actions that, when done well, increase the number of UF advocates and available resources, and can be initiated relatively independently of institutional constraints.

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Appendix A. Data collection overview

Table A1. Overview of local authorities (LAs) providing different types of data (1 = *yes*, 0 = *no*) (% of all 32 Scottish LAs).

LA	Interview data (town)	Questionnaire data	Interview or questionnaire data
Aberdeen City	0	1	1
Aberdeenshire	0	1	1
Angus	0	1	1
Argyll & Bute[a]	0	1	1
Clackmannanshire	0	1	1
Dumfries & Galloway	0	0	0
Dundee City	1 (Dundee)	0	1
East Ayrshire	0	1	1
East Dunbartonshire	0	1	1
East Lothian	0	0	0
East Renfrewshire	0	1	1
Edinburgh, City of	0	1	1
Eilean Siar[a]	0	1	1
Falkirk[a,b]	0	1	1
Fife	1 (Glenrothes)	1	1
Glasgow City	1 (Glasgow)	1	1
Highland	0	1	1
Inverclyde	0	0	0
Midlothian	0	0	0
Moray	0	1	1
North Ayrshire[a]	0	1	1
North Lanarkshire	1 (Cumbernauld)	0	1
Orkney Islands	0	1	1
Perth & Kinross	1 [multiple towns]	1	1
Renfrewshire	0	0	0
Scottish Borders[a]	1 [multiple towns]	1	1
Shetland Islands	0	0	0
South Ayrshire	1 (Ayr)	0	1
South Lanarkshire[a]	0	1	1
Stirling	1 (Stirling)	1	1
West Dunbartonshire[a]	0	1	1
West Lothian	1 (Livingston)	0	1
Total	**9 (28%)**	**22 (69%)**	**26 (81%)**

Note: N.B.: [a] = Only partial questionnaire data available; [b] = Questionnaire data derived from completed pilot questionnaire.