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The right tree at the right place? Exploring urban foresters' perceptions of assisted migration

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ABSTRACT

Urban trees provide multiple benefits in the form of services to citizens, and urban forests are generally managed in order to maximize those benefits. However, urban environments feature harsh growing conditions for trees, and rapid climate change is now compounding existing stresses. In some cases, the habitat range of tree species is expected to shrink or to shift. To alleviate tree maladaptation and sustain the provision of services, urban foresters could resort to assisted migration (also known as assisted colonization). Assisted migration is an adaptation strategy where species are deliberately relocated out of their historical range in anticipation of future climatic change. The ecological risks and uncertainties it entails, as well as the value-laden dimensions involved in this strategy, have altogether made it a highly debated issue. In order to know if assisted migration is being considered as a management strategy, and to facilitate future policy and decision making, we conducted in-depth interviews with 18 urban foresters from southern Ontario about their practices and perspectives towards assisted migration. We found that although they are generally favourable to a constrained implementation of assisted migration, it is not part of their ongoing management strategies. Opinions are divided on the current need for assisted migration as well as the prevalence of the risks and uncertainties involved. However, respondents agree that trials and experiments need to be undertaken, along with tree inventories and monitoring, but so far efforts are few and scattered across municipalities and actors. Implementing assisted migration will require community involvement, knowledge sharing, leadership from higher levels of government, and coordinated efforts at multiple scales.

1. Introduction

More people now live in urban areas than in rural areas (UNFPA, 2007), and the trend towards urban living is expected to continue. Cities represent the environment where most people experience nature, and where they are exposed to life and natural processes (Dearborn and Kark, 2009; Kowarik, 2011). In particular, urban dwellers benefit from the multiple services provided by forests, including a myriad of ecological, social, and economic services (Bolund and Hunhammar, 1999; Conway and Urbani, 2007; Pickett et al., 2011). Yet the urban landscape is characterized by a high density of people and their infrastructure, which often results in harsh growing conditions for trees (Konijnendijk et al., 2006). These conditions include the urban heat island effect, altered hydrology, altered soil and air quality, low genetic diversity, invasive species, and heavy anthropogenic disturbances (Pickett et al., 2001, 2011; Francis et al., 2011; City of Toronto, 2012).

Rapid climate change is now expected to act as a compounding factor, with changes in temperatures and precipitation patterns causing considerable stress to urban forests. Trees will simultaneously experience increases in extreme weather events, as well as pest and disease outbreaks (McKenney et al., 2009; Winder et al., 2011). Trees may be able to adapt to such changes, but they are generally highly adapted to local conditions and have long generation times, so they are ill-suited to abrupt change (Pedlar et al., 2011; Williams and Dumroese, 2013). Alternatively, populations may migrate in response to rapid climate change, but trees have limited mobility and urban environments tend to be highly fragmented, which inhibits their capacity to migrate (Woodall et al., 2010). While trees migrate at varied rates, they average about 50 km per century, which is too slow to keep pace with the 300 km northward climatic shift projected to occur in Canada within the next 50 years (under a two-degree increase in mean annual temperature, see Aubin et al., 2011). The evidence in fact suggests that the distribution of tree species is already lagging climate change (e.g., Zhu et al., 2011). As a consequence, certain species will become maladapted and local populations could go extinct, affecting the overall health of the urban forest and thus the benefits that derive

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from it. Resource managers must ensure that the urban forest can still provide those important services to citizens.

In response to these challenges, new conservation tools and goals are being considered (Sandler, 2013). Conservation practices have historically been rooted in restoration and preservation, while they are now slowly shifting towards adaptation and resilience (Leech et al., 2011). A prime example is assisted migration (hereafter AM, also known as assisted colonization), which consists of moving and establishing species or populations outside of their historical range to a new location where the climate will be more suitable under expected conditions of climatic change (see Minteer and Collins, 2010; Schwartz et al., 2012). Assisted migration is an adaptation strategy that has been highly debated, partly because it strays from traditional conservation values (e.g., Palmer and Larson, 2014).

Assisted migration does not just concern risks to rare species threatened by climate change. For example, AM in British Columbia, Canada focuses on moving commercially valuable populations of trees to maintain the productivity of forestry operations (Aubin et al., 2011; Ste-Marie et al., 2011; Pedlar et al., 2012; Klenk and Larson 2015). We therefore follow Pedlar et al. (2012) and distinguish species rescue AM from forestry AM. The former is specifically intended to rescue endangered species while the latter seeks to maintain forest productivity and certain ecosystem functions and services. While species rescue AM would typically involve the movement of species well beyond its range, forestry AM mostly consists in the movement of seeds at the northern edge of their range, or slightly beyond it (Leech et al., 2011). Unlike species rescue AM, which remains open to debate, forestry AM has been deemed a key strategy to respond to climate change in the forest sector (Pedlar et al., 2012; Williams and Dumroese, 2013). British Columbia has extensive ongoing trials of AM forestry, Québec and Alberta are changing their seedling policies in preparation for AM applications, and other jurisdictions are preparing by collecting information and setting up decision-making tools (Pedlar et al., 2011, 2012).

To date, however, urban forests have received little attention within the AM literature (Yang, 2009; Woodall et al., 2010). Urban forests could benefit from both forms of AM, both to help sustain ecosystem services and to contribute to the rescue of threatened species. Urban foresters could integrate tree populations and species from the south or assist their northward movement if they are at risk. Yet Yang (2009) has found that despite projected climate change impacts, urban foresters in the Philadelphia region would most likely continue to plant the same tree species. Woodall et al. (2010) similarly conclude that the potential for AM in urban areas is constrained and ambivalent. Nonetheless, climate impacts are experienced at the local scale (Measham et al., 2011), so urban foresters are encouraged to experiment and see which species do best under current climate conditions and to assess their viability under changing conditions (Wieditz and Penney, (2007); Williams and Dumroese, 2013; Trees Ontario, n.d.). Moreover, urban foresters receive mixed recommendations about current planting practices, with some documents putting a strong emphasis on planting native, ideally locally-sourced species, whereas others explicitly mention AM or discuss species movement and migration (Colombo et al., 2008; Trees Ontario, n.d.; City of Toronto, 2012). To the extent that urban foresters retain the former emphasis (e.g., in traditional 'restoration' projects), it is important to draw attention to the potential for AM in the urban context—both to aid species conservation and to maintain or improve function.

This research in southern Ontario, Canada aims to explore how urban foresters perceive AM and the extent to which it is being considered in the management of the urban forest. We sought to answer two main questions:

(1) How favourable are urban foresters to AM, and which preferred goals and underlying values guide their position?; and
(2) To what extent are urban foresters integrating adaptation strategies in their planning and management?

By assessing the place that adaptation strategies hold in current management and planning, this research can provide guidance for policy making and help to advance the dialogue about AM.

2. Methods

Our main purpose was to investigate the perceptions and planting practices of urban foresters in the context of climate change adaptation. For this exploratory study, we used a qualitative interview-based approach to obtain in-depth analysis of experiences (e.g., Hay, 2010), rather than seeking a quantitative and representative sample. We focused on the perspective of urban foresters, as opposed to arborists, because of their extensive knowledge with the phenomenon under study (Marshall and Rossman, 1995). Within municipal forestry, urban foresters, arborists and even park managers will share responsibility for implementing urban forestry management plans. However, urban foresters work at a larger, systemic scale and are trained to understand and analyze ecosystem functioning (Schwab, 2009), so they have a greater influence on tree-related policies and urban forest management plans. We did not seek participants on the basis of their educational background, as it was clear in the beginning of the research that the term "urban forester" can incorporate a variety of educational background and experiences. We instead sought professionals who identified as urban foresters, either from their training or their work responsibilities and experience.

We used purposive sampling towards our objectives (Hay, 2010), first seeking respondents through a preliminary internet search of urban forestry organizations in southern Ontario, particularly around Toronto and the Greater Toronto Area (GTA). We focused on southern Ontario because it contains the "Carolinian" Life Zone, which harbours a high proportion of Canada's rare species (Parks Canada, 2009) and is thus pertinent to considerations of species rescue AM. We focused on the GTA because of Toronto's recent adoption of an urban forest management plan (City of Toronto, 2012) and the possible impacts it may have on surrounding municipalities. We expanded our respondents through snowball sampling, by asking each respondent to provide the names of other potential informants. Finally, we obtained additional participants through a recruitment email to the Canadian Urban Forest Network mailing list. Although our study is focused in this region, it has implications for thinking about the challenges of applying AM in urban areas elsewhere.

We utilized in-depth, semi-structured interviews in this research, with ethics clearance from the Office of Research Ethics at the University of Waterloo (which granted anonymity to respondents). The interview questions were modified from AM frameworks and key questions in the literature (e.g., McLachlan et al., 2007; Richardson et al., 2009). The questions were divided into two main categories (see Appendix A for our questionnaire). The first concerned urban forestry goals and the drivers of species selection, while the second concerned the acceptability and feasibility of AM. Since AM is a relatively new concept that could be unfamiliar to potential participants, the main interview questions focused on the underlying concepts of AM and climate change adaptation rather than technical aspects of the definition of AM. The interviews were recorded, transcribed verbatim, and then the transcripts were coded using a grounded approach (Gibbs, 2007; though our codes ultimately reflect the literature on acceptability and feasibility).

We interviewed 18 informants, at which point our understanding of urban foresters' thinking about this issue was saturated. It is worth noting that participants were difficult to obtain, in part because the ice storm that hit southern Ontario in December 2013 restricted their availability. The interviews were conducted from September 2013 to June 2014, for about one hour each. Ten interviews were face-to-face, with the remainder by phone. We obtained a breadth of respondents, including ten from non-profit organizations (including two from local conservation authorities), four from different municipal governments, three from consulting businesses, and one from a school board. The non-profit organizations in the sample focus on urban forest management (with the exception of the conservation authorities who have a broader conservation goal) and are dedicated to tree planting and education about the benefits of urban trees (though their mandates range from quite local to national in scale and from a focus on private to public land). The businesses were focused on urban forestry, on both private and public land, and offer services ranging from individual tree care to urban forest assessment at the systemic level. The school board was included on the basis that it owned an important piece of property where trees are managed. Although not all respondents operated as trained foresters, all of them were responsible for planning and/or managing urban forests.

3. Results

Our coding revealed four main topics within the responses: (1) species selection and underlying goals; (2) urban forestry and conservation tools; (3) acceptability of AM; and (4) feasibility of AM. We elaborate these categories in each section below.

(1) Species selection and underlying goals

This category concerned the respondents' motivations for selecting tree species for planting, based on their perceptions and prioritization of different tree species. This category is also linked to the underlying goals that could drive future implementation of AM in the urban forest sector. Some of the key themes uncovered by the coding include tree establishment, ecosystem services, biodiversity and resilience, and exotic vs. native species.

Respondents expressed concerns about the challenges of bringing a tree to maturity in the urban environment. When asked about the most important dimensions to consider when selecting a tree species, the respondents prioritized tree establishment. Their responses suggest that the characteristics of the urban environment at the planting site are the main drivers of species selection. The provision and maintenance of ecosystem services were, second to tree establishment, the most important consideration in urban forest management for the respondents. One respondent stated, "the whole activity of planting trees in urban settings mostly, unless it's in a ravine or natural area, is to confer benefits to the people who live among the trees," and another observed that "biodiversity, I think it's kinda taking a backseat right now, we just need our cities to work." Carbon sequestration and cooling were often mentioned, and respondents suggested that the demand for such services is increasing in the urban forest sector: "People really like to know how much carbon is being sequestered, say by a tree or a few trees." The respondents also raised concerns about the lack of species and genetic diversity in urban forests.

Ultimately, the choice of species is both tied to the planting location and to the function it serves–for instance, an exotic species may be chosen to provide shade along a busy street downtown. While respondents preferred native species, this was largely tied to concerns about biodiversity and the maintenance of naturalized areas (e.g., watersheds, woodlots, and ravines) within the urban environment. Non-native species still appear to be utilized within cities as amenities. As one respondent explained: "We do sometimes plant non-natives if they serve a particular purpose." Some respondents recognized that although they follow a strictly native planting practice, it might be ill-suited for long-term planning: "We have a fairly strict policy of only planting native species [. . ., but] I think we might need to rethink that position." Yet, in the context of assisted migration, there are concerns about the added risk of non-native species becoming problematic invasive species; as one respondent observed, "I wouldn't want to be throwing species from southern climate around [. . .] where there is potential that they could integrate into native ecosystems."

Our results concerning planting practices suggest that unofficial AM is indeed underway in southern Ontario's urban forest sector. For some urban foresters, the term native was restricted to local provenance: "I mean native, originally native, not native to somewhere in North America or something like that." However, in other instances, Carolinian species were sometimes cited as native, and planted for the services they provide, even though they were not native to the local region. As one respondent noted, "the cities themselves are planting just about exclusively Carolinian species, as you would define more southern species from here." A good example would be the plantings of Kentucky Coffee-tree (*Gymnocladus dioicus)*, a species that is planted in Toronto in anticipation of warmer climates even though it is found 'naturally' much further south in the province (Agrell, 2011).

(2) Urban forestry and conservation tools

This category concerns the management tools used by urban foresters for their urban forestry and conservation objectives, such as tree inventory, monitoring, and trials and experiments. Alongside traditional conservation tools (e.g., land protection and corridors), these tools help with the implementation of AM and other climate change adaptation strategies.

Our findings revealed that the interviewees still relied heavily on traditional conservation methods. They engage in restoration activities within naturalized areas and depend on protected areas for biodiversity conservation and habitat connectivity. As summarized by one respondent, "there's always going to be a reserve for something. It just might not be the same thing that's there today." Adaptation strategies, such as assisted migration, are just starting to appear in the planning and management of the urban forest. The use of data collection techniques such as tree mapping, inventories and monitoring is uneven from one municipality to another, as well as from one organization to another. Many respondents were unaware of monitoring programs aimed at following and measuring climate impacts on native species, and the overall results suggest that data collection programs were not prevalent in southern Ontario's urban forests. One urban forester commented, "I can't think of any actual programs, not to say there aren't any."

Our interviewees were all in favour of trials and experiments with southern tree species. Despite the general support for trials with more southern species, very few of the respondents had initiated or were taking part in such experiments. A few respondents did not feel confident enough with the science to proceed with plantings of southern species, or they stated that their organization did not have the capacity to proceed with AM or run experiments. As one respondent stated, "there's a big difference whether they're [urban foresters] trained in science versus they are just tree managers in some way."

(3) Acceptability of assisted migration

This third category encompasses issues related to urban foresters' perception of the risks, threats, uncertainties, and opportunities presented by AM. One interviewee summarized the issues as follows: "Our trees are going to be stressed out [. . . and] a lot of them are not going to survive where they currently are but are going to survive further north." Accordingly, while none of the respondents disagreed with implementing AM, most adopted a prudent attitude towards it: "in concept I agree, but it needs to be done very cautiously with a lot of research." Another stated, "I would be supportive as long as there is some science to support it." When asked about the possibility of moving endangered species further north, one respondent said: "I don't have a problem with moving endangered species around, I think the question is why would you want to, what's the point of that, [and] what is our master plan for our landscapes." This last quote reflects the transition towards a management approach directed towards ecosystem functionality as opposed to species-focused conservation goals (see below).

Risk assessments and science-based decision-making were frequently raised when discussing AM. Specifically, the risks of negative impacts as well as the cost and time frame involved in the process contribute to the lukewarm response of urban foresters to AM: "I think it could become an overly arduous process where we're trying to manage so many different elements, I would worry about the amount of money invested in any AM program." Another one added: "it's absolutely a good idea [. . . yet] I think it's a challenge bringing the science to the practical reality of urban forestry."

A few respondents were quite supportive of AM, and did not see uncertainties and potential risks as a barrier to implementing it. One observed that "Moving some of them makes sense. It seems to me if they'll survive and if we understand enough how migration has happened in the past, which I believe we do [. . . and] we've interrupted the pace of change, so we now need to help nature follow the pace of change." Some respondents even perceived the expected climate change impacts as opportunities to improve urban forest management. Crisis, they argued, can foster awareness and ultimately improve how we manage forests by shifting attitudes. In the words of one respondent: "Things like the ice storm helped open up opportunity for discussion and so I feel the heat of this living threat [yet] at the same time it does open up an opportunity that we need to be ready to take advantage of."

(4) Feasibility of assisted migration

The last category pertains to whether institutional arrangements act as barriers or enablers for current and future implementation of AM. The main themes are human and financial resources, policy and legislation, urban forestry practices, and governance and collaboration.

The interviews suggest that there are many barriers to the widespread implementation of AM in the urban forest sector. Respondents insisted that staff shortages and constrained budgets were a significant limitation to management options. One noted that "Urban forestry is already an underfunded, under-recognized sort of practice. . . For the most part, others, especially smaller communities, just don't have the budget or interest to even maintain what they have, so thinking about climate change is off the radar."

In addition, a common theme was the need to increase provincial and federal support to the urban forest sector. One interviewee thought that "a big problem there is in the urban forest governance. . . it's all the hands of local municipal governments already and they may not be able, they may not have the capacity. . . You need some provincial leadership or some federal leadership and Canada doesn't have that." The lack of coordinated efforts and communication between the agencies conducting trials could delay policies meant to ensure a regulated used of AM. Constraints are reputedly challenging regular management objectives such as tree maintenance (e.g., pruning), and therefore AM might only be an option for a few species of high concern. As one respondent explained: "I think it's just another management consideration in an area that's already highly constrained by budgetary, environmental and other constraints."

The issue of local provenance was commonly raised in the interviews. Urban forestry practices are influenced by nursery and horticultural practices. These can both drive or challenge the implementation of AM. The results demonstrate that nurseries have a major role in the plantings as they ultimately determine planting stock and seed provenance. While some organizations were very diligent in planting exclusively locally-sourced trees, others admitted that within the field of urban forestry it is more often than not an ideal rather than common practice. As one respondent put it: "That's the trouble, because in the trade you know you have native species coming from Ohio, in terms of trees, and from Montreal, British Columbia, Oregon even." Nurseries, as an industry, were also held accountable: "We are worried about moving species around, yet we're already doing it . . . the whole nursery industry is completely based on that." None of the interviewed foresters were aware of newly adopted legislation regarding the movement of seeds (e.g. seed zoning) and of species within Canada (Table 1).

4. Discussion

Our results suggest that although urban foresters are aware of AM as a strategy for climate change adaptation, it remains more of a theoretical concept than a management tool. However, "unofficial" AM is arguably well underway, with southern species being planted at the northern edge of their range. Using McLachlan's framework (2007), urban foresters have adopted a "constrained" form of AM, where decisions are made based on substantial data gathered in asset management programs. Most respondents agreed with implementing AM on the grounds of expertise, scientific information, and careful risk assessments. The main expressed concerns were the uncertainty surrounding the effects that climate change will have on trees, such as the distribution of species, as well as the risks of negative impacts following the translocation (e.g., invasiveness).

In the light of these results, AM seems unlikely to be implemented in the near future to maintain or enhance biodiversity, but rather to provide ecosystem services such as the case in forestry AM. We found that the protection of rare species mostly falls outside the scope of urban foresters, so they may not implement species rescue AM on their own; organizations specializing in species conservation might be in a better position to perform species rescue AM. So far, AM is being used to sustain ecosystem services in areas where native trees are not adapted and their growth is compromised. In this context, our respondents were hesitant about the potential contribution of AM to restoration projects, even though the goals of ecosystem restoration are challenged by rapid climate change (Park and Talbot, 2012) and it has thus been recommended that policies and regulations be adjusted (e.g., seed zones) (Millar et al., 2007). Under a changing climate, there are reasons to consider novel, exotic species for plantings in restoration projects, but there is still a preference for native species (Alvey, 2006; Sandler, 2013). Rather than attempting to recreate historic conditions, urban foresters could plan on establishing ecosystems with pre-determined functions and consider novel species assemblages (see Harris et al., 2006). Our findings, however, indicate that urban foresters remain reluctant to introduce species in those naturalized areas where restoration projects take place.

We also found that effective use of AM will have to overcome limited information on the current and evolving state of the urban forest. Conducting localized inventory and monitoring is a start towards adaptation, but comprehensive and ongoing data collec-

Table 1
The main categories, and underlying themes, by which urban foresters interviewed for this study assessed the topic of assisted migration.

Species Selection and Underlying Goals	Urban Forestry and Conservation Tools	Acceptability of Assisted Migration	Feasibility of Assisted Migration
1. Tree establishment	1. Asset management	1. Risks, threats, and uncertainties	1. Human and financial resources
2. Ecosystem services	2. Trials and experiments	2. Opportunities	2. Policy and legislation
3. Biodiversity and resilience	3. Traditional conservation tools		3. Urban forestry practices
4. Exotic vs. native species			4. Governance and collaboration

tion allows urban foresters to detect problems early and to manage proactively (Savard et al., 2000; Dietz et al., 2003; Alvey, 2006; Conway and Urbani 2007; Barker and Kenney, 2012). It also makes it easier to set management goals and clearly identify objectives. In addition, although AM has the potential to preserve urban forest health, the lack of a clear definition to guide operations could delay decision-making. Urban foresters need to know how exactly urban forests could benefit from AM to integrate it into their management. Vulnerability assessment could be a valuable contribution to determine which species are most vulnerable and allow early action to be taken to maintain forest health (Ste-Marie et al., 2011). Urban foresters mostly work with canopy cover targets, but developing a set of criteria and indicators would further help managers improve tree health (Kenney et al., 2011).

There are several potential paths forward for management of urban trees in the face of climate change. To ensure a more coordinated approach to urban forestry across Ontario, there have been suggestions to adopt a national plan of action (Barker and Kenney, 2012). Smaller municipalities and organizations often have fewer resources to conduct data collection programs that include systematic inventory and monitoring, even though they are just as vulnerable to urban forestry challenges as large urban centres (Barker and Kenney, 2012). A national strategy for urban forests would provide some guidance to those smaller municipalities and could contribute to even out management across Ontario. Alternatively, the obstacles could be overcome through partnerships and actors that offer leadership. Urban environments have highly fragmented habitats and ownership and urban forestry is often limited by resources, so implementing AM will require problem-solving through partnerships and collaboration. Institutional leaders could play a key role here in shaping change and innovation to lead to successful partnerships (Folke et al., 2005).

As recognized elsewhere, AM is not fundamentally a technical issue, but instead requires attention to fundamental questions of value and governance (e.g., Park and Talbot, 2012; Schwartz et al., 2012; Klenk and Larson, 2013; Neff and Larson, 2014). All respondents agreed that the public should play an active role in the management of the forest because a large portion of the urban forest is privately owned. Informants were unanimous on this matter, stating that “it’s really a joint responsibility” and that “in many cases it’s the citizens’ interests and passions that end up driving policies so there is always going to be a very large role for society there.” To increase the acceptability and feasibility of AM initiatives, urban foresters, as well as other relevant actors from NGOs and businesses, should collaborate with the public. Initial consultations to inform and obtain the public’s consent and public participation could facilitate the movement of species and increase the chances for successful establishment. For example, site location and conditions within the urban environment are a major factor in tree planting, and private lands could potentially be used as planting sites.

Another advantage of public engagement is that access to all available information can contribute to better outcomes. Consider the case of the Torreya Guardians, which is often used as a call to regulate AM (e.g., McLachlan et al., 2007). The Torreya Guardians are a citizen’s group responsible for the translocation of an endangered conifer, *Torreya taxifolia*, from Florida to establish populations in North Carolina (http://www.torreyaguardians.org; Schwartz et al., 2012). If governmental agencies do not develop updated policies or review their seed zone guidelines, in concert with stakeholders, these types of initiatives could escalate and ENGOs and others could be motivated to undertake AM on their own terms. When told about the Torreya Guardians’ AM initiative, one supportive respondent stated that “that’s the sort of thing that we need to see more of [. . .] I think it’s also the only sustainable way of dealing with [the problem], because otherwise you’re looking at a process that’s so expensive and where the resources are so sparse, that you have a situation that’s designed to fail.”

Finally, we wish to point to some next steps for building upon the results of our exploratory study. Clearly, similar research in other areas would help to broaden our understanding of the extent to which urban foresters are adopting methods for adaptation to climate change, including AM, perhaps especially in terms of their feasibility. Such studies could also help us to better understand the reasons that urban foresters adopt (or reject) AM, as well as the conditions affecting their reasoning. In an era where adaptation to the changes wrought by climate change will only become more critical with time, our research hopefully provides another entrée into broader discussions about how species selection and conservation must themselves change in coming decades.

5. Conclusion

Constrained AM is indeed being considered as a potential strategy in urban forests. In practice, it remains at the trial stage, with relatively few experiments across the region of our study. It will most likely be used for the provision of specific ecosystem services, as species at risk were seldom raised as a concern. Rather, urban foresters were much more worried about the canopy and sustaining the benefits provided even by a stressed urban forest. There is a long way to go before AM becomes officially and extensively implemented as an urban forestry tool. Financial constraints, as well as a lack of leadership to inform a clear direction and coordinated actions, are the main barriers.

With all of the challenges the urban foresters currently face, and with limited government support, municipalities may be left to manage reactively, reacting to crises as they arise, as they are currently doing. There is a significant need to bring urban foresters from a variety of backgrounds and jurisdictions together to discuss AM in the interests of a more proactive approach. We recommend more coordinated action to ensure information sharing among urban foresters, and to encourage municipalities to initiate asset management strategies.

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Appendix A. Interview Questionnaire

- *Introduction*

- What do you do as part of your work in this organization?
- From your experience, what do you think is the biggest challenge in the field of conservation and restoration?
- How do you think climate change will be impacting ecosystem services provided by the urban forest?
- In your work experience, what place does climate change adaptation currently hold in the management of the urban forest?

- *Questions about urban plantings*

- What are the most important dimensions to consider when planting trees in urban settings?
- Do you plant both native and non-native species? What is the balance? How does that fit in with the integration of climate change adaptation strategies in urban forest planning?
- How can you manage biodiversity conservation with the specific requirements of urban forestry?
- How do you go about the provenance of seeds in nurseries when choosing trees to plant? Have there been changes in the seed source selection?
- What do you think of trials or experiments with southern tree species in the urban area? Do you believe your organization has the capacity to initiate or help with such experiments?
- Is there an ongoing monitoring program to see how native species are affected by the changing climate? If not, why not? If there is, can you tell me more about it
- Are you aware if there has been changes in the policies that regulate the movement of seeds and tree species? Which changes? Do you believe it should be regulated?
- What do you think of moving a possibly endangered species, animal or plant, up north because it's going to do well with climate change?

- *Conclusion*

- What role should the public play in regards of caring and managing the urban forest?
- Do you know anyone who would be interested in participating in my research project?

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