Land Use Policy 51 (2016) 66–75

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Management of vegetation under electric distribution lines will affect the supply of multiple ecosystem services

Jérôme Dupras[a,b,*], Cynthia Patry[c], Rebecca Tittler[d], Andrew Gonzalez[b,e], Mahbubul Alam[f], Christian Messier[a,d]

[a] Institut des sciences de la forêt tempérée, Université du Québec en Outaouais, Canada
[b] Quebec Center for Biodiversity Science, Canada
[c] Corridor appalachien, Canada
[d] Center for Forest Research, Université du Québec à Montréal, Canada
[e] Department of Biology, McGill University, Canada
[f] Betty & Gordon Moore Center for Science and Oceans, Conservation International, USA

ARTICLE INFO

Article history:
Received 23 August 2014
Received in revised form 16 March 2015
Accepted 3 November 2015
Available online 19 November 2015

Keywords:
Vegetation management
Power lines
Ecosystem services
Delphi method

ABSTRACT

In this study, we estimated the impact of different management strategies on the ecosystem services provided by the vegetation under electric power lines in urban and rural areas. Two management scenarios were evaluated in urban areas: (a) complete removal of trees that interfere with power lines, and (b) pruning of these trees. Four management scenarios were evaluated in rural areas, where power lines cut through wood lots and forests: (1) clear-cutting with whole-tree removal, (2) clear-cutting with slash left on site, (3) selective logging with slash left on site, and (4) tree pruning only. Because it was not feasible to carry out field experiments to examine the effects of all of these management scenarios on fourteen ecosystem services, we used the Delphi method to solicit expert opinion and address testable predictions and preliminary management recommendations. According to this expert survey, pruning is expected to have little or no effect on a range of services provided by trees, woodlands and forests either in rural or urban areas. On the other hand, all other scenarios are expected to have similar effects on at least half the services evaluated. Based on these results, we recommend that pruning be prioritized over other management practices as much as possible in urban and rural settings.

1. Introduction

The links between biodiversity, ecosystem function and ecosystem services (ES) and between ES and human well-being has led to the development of a normative approach to conservation and natural resource management (Millennium Ecosystem Assessment, 2005). ES are the goods and services provided by ecosystems from which humans derive benefit. This concept aims to characterize ecosystems according to a series of attributes that make life possible for humans (Boyd and Banzhaf, 2007). The generally accepted reasoning is that ES arise from the ecological processes and interactions of the biotic and abiotic components of ecosystems (Millennium Ecosystem Assessment, 2005). Thus, considering ecosystems and natural capital as reserves of natural resources, ES are all the benefits (e.g., social, economic, health, spiritual) generated by this capital in both managed and unmanaged contexts (Millennium Ecosystem Assessment, 2005).

Trees, woodlands and forests provide multiple ES. For example, supporting ES include nutrient cycling, soil formation, and primary production of biomass (Millennium Ecosystem Assessment, 2005). These supporting services allow biodiversity and ecosystems to generate services that are useful to humans, namely provisioning, regulating and cultural services. Provisioning services include direct consumption by humans of natural resources such as wood, food, and fibre. Regulating services include processes that provide an environment conducive to human well-being, such as climate regulation, air quality regulation, pollination, and erosion control. Cultural services relate to intangible assets that humans get from ecosystems and biodiversity; these include cultural, aesthetic and recreational values.

Human infrastructures, like roads, buildings, and power lines directly or indirectly impact the quality and quantity of ES provided

* Corresponding author at: Institut des sciences de la forêt tempérée, Université du Québec en Outaouais, Canada.
E-mail address: jerome.dupras@uqo.ca (J. Dupras).

http://dx.doi.org/10.1016/j.landusepol.2015.11.005
0264-8377/

by trees. In this study we ask whether electric power distribution networks affect ES supply. In particular we asked whether a power line right-of-way (ROW), influences the production of ES. This information is important for public institutions like Quebec's power company, because it is required to inform decisions about best practices for ecosystem management.

Any activities during, before, and after construction of power lines affect landscapes differently. Maintenance of existing lines often involves the management of vegetation on the ROW, which requires complete or partial removal of trees and shrubs growing under power lines. As trees and other vegetation form habitat for many plant and animal species some disturbance types on ROWs could have negative consequences for biodiversity conservation (Berger, 1995; Goosem, 2004; Söderman, 2006).

In addition to these habitat functions, ROW vegetation generates many other ES: habitat for insects that pollinate agricultural fields (Russell et al., 2005) and potentially root systems that reduce soil erosion, woody material that store and sequester carbon, and beautiful structures that affect landscape aesthetics that eventually affect property prices. Although there are several studies reporting the negative impacts of power lines on local property prices (see Refs. Jackson and Pitts, 2010; Elliott and Wadley, 2002), many of those negative effects on landscape aesthetics can be reduced by effective management of vegetation and landscapes in and around ROWs. Earlier studies have found that many negative impacts of power lines, especially on wildlife, can be mitigated through effective ROW management, including leaving natural vegetation onsite, retaining rooted trees, snags, logs, and mid-seral vegetation, and protecting fruit and nut trees, which serve as a food source for wildlife (Berger, 1995; Clarke et al., 2007; Storm and Choate, 2012). Different strategies have been put forward to minimize the environmental impacts of transmission and distribution power line ROWs biodiversity and ES (Berger, 1995; Clarke and White, 2008; Young, 2010). The use of pruning techniques, selective cutting, retention of some structural elements, and other environmental practices can minimize the impacts of power line networks, by reducing landscape fragmentation and the loss of natural habitats (Clarke and White, 2008; Young, 2010).

Ideally, field studies and experiments could be carried out to investigate the effects of various land use policies and practices on biodiversity and ES. However, given the large number of ES that might be affected by various land use policies and practices, this approach would be complicated, time-consuming, and expensive. In the meantime, management decisions must be made. To tackle this problem, we used a qualitative assessment approach, the Delphi method, to evaluate the integrity of the natural environment and the production of ES by vegetation under electric power distribution lines. Group communication methods such as this have led to fairly good estimates in a number of studies (Young, 2010). Among the existing methods of group communication, the Delphi Method, based on expert opinion, has been the most widely recognized over the past 60 years (Okoli and Pawlowski, 2004). A quick search on March 2015, of the Web of Science for the words Delphi method indicate 835 publications in 2014 alone, the method being used for everything from studies on mental health issues (e.g., Ross et al., 2014) to environmental risk assessment (e.g., Saffarian et al., 2014). The use of this qualitative assessment approach can overcome a lack of scientific literature and/or an inability to do field studies and experiments.

This study aims to make predictions about the effects of different management practices to control vegetation under electric distribution lines on the production of ES in rural areas and at the tree scale in urban areas. It uses the Delphi method to explore the opinions of experts on the impact of six different management strategies.

2. Methodology

We used the Delphi method to quantify variation in the production of ES resulting from various vegetation management practices. This technique, based on iteration and feedback acquired from open questionnaires, is anonymous, and tends towards consensual answers (Okoli and Pawlowski, 2004). In practice, respondents are first asked to respond to an initial questionnaire. The results of this questionnaire, accompanied by a summary of the general trends, divergent opinions and supporting arguments, are then sent to each expert in a second round. Finally, the experts are invited to react and respond to this second questionnaire, reviewing their positions in light of this additional information. Although consensus is often reached after two or three rounds, iterations may continue until sufficiently convergent positions are acquired (Okoli and Pawlowski, 2004). The main advantages of the Delphi Method are the compilation of anonymous information within a group of experts, the flexibility in data entry (time and space), and controlled feedback that allows for credible consensus (Okoli and Pawlowski, 2004).

2.1. Experimental Design

Six different types of existing tree management of the electrical distribution network were defined by a team of experts and the power company's team to estimate the impacts these different management scenarios have on ES. These scenarios represent the current state of management and are applied to two settings: rural and urban areas. In rural areas, 14 ES were assessed under four different scenarios: (1) clear-cutting with whole-tree removal, (2) clear-cutting with slash left on site, (3) selective logging with slash left on site, and (4) tree pruning (Tables 1 and 2; Fig. 1). In urban areas, 10 services were evaluated based on two scenarios: whole-tree removal and single tree pruning (Tables 1 and 3; Fig. 1). Six of the ES examined in rural areas were considered irrelevant for urban areas (food production, timber resources, flood and drought control, biological control, nutrient cycle/soil formation and recreational activities), whereas two were only considered relevant for urban areas (local climate regulation and water runoff control) (Table 1). We chose these ES as being the most relevant based on a literature review of the ES provided by trees, woodlands, and forests in urban and rural areas (Nowak et al., 2006; Haines-Young and Potschin, 2008; De Groot et al., 2010; Dobbs et al., 2011) as well as well as on studies performed on forest-related ES in Quebec (Dupras et al., 2015; Dupras and Alam, 2015)

2.2. Selection of Experts

We selected experts based on three criteria: (1) they are experts in ES science (they held a Ph.D. and actively carried out research in this field); (2) they are familiar with forests and trees located in the urban and rural areas of southern Quebec (they published peer-reviewed studies on these types of ecosystems); and (3) they read and write French adequately since the questionnaire was in French.

After developing these criteria, we compiled a list of Quebec-based experts and invited them to participate in the study. The invitations included an overview of the process of the investigation and its objectives. Participant anonymity was preserved: the identity of each expert was known only to the researchers. Those experts who agreed to participate in the study were contacted anew and provided with the further details.

Thirty-six experts were invited to participate in the study. Of these, 19 agreed to take part but 2 did not access the questionnaire's website. In the end, a total of 16 experts completed the two rounds required to obtain adequate results. Of the 16, 15 were academics and 1 was a public service researcher. Expertise varied from