



Special Issue Article: Advancing Environmental Conservation: Essays In Honor Of Navjot Sodhi

## A tropical perspective on conserving the boreal ‘lung of the planet’

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## ABSTRACT

Navjot Sodhi is best known for his advancement of tropical ecology and conservation science; however, his research origins were in fact based in the boreal forest ecosystem of Canada. Ironically, the less-studied ecosystems of the tropics have recently received much more conservation attention than northern biomes, despite the boreal forest (i) representing about one third of all remaining forest on the planet (and about 50% of the world's remaining tracts of large, intact forest), (ii) sequestering about 30% of the Earth's stored terrestrial carbon, and (iii) becoming increasingly fragmented with ecologically contiguous patches constituting only 44% of its entire area. These heightened threats of fragmentation and increasing fire frequency associated with expanding human industry in the boreal zone, along with climate change, mean that more international focus on the plight of the boreal ecosystem is warranted. Prior to his death, Navjot Sodhi had accepted a position at the University of Toronto where he planned to apply his keen, transdisciplinary approaches to boreal conservation science in an attempt to prevent the future destruction of planet Earth's second ‘lung’. Although he never realised this dream, here we provide an overview and examples of how appropriate boreal forest management can be achieved.

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## Contents

1. Introduction . . . . .	50
Acknowledgement . . . . .	52
References . . . . .	52

## 1. Introduction

Although he left an extensive legacy of contributions to ecology and conservation, the passing of Navjot S. Sodhi is tragic not least because he potentially had so much more good science to offer. Navjot was best known for his most recent writings on the ecology and conservation of tropical systems; indeed, he ‘wrote the book’ on *Tropical Conservation Biology* (Sodhi et al., 2007). This included a range of work on particular species (e.g., Brook et al., 2003; Lim et al., 2003; Lim and Sodhi, 2009), various community-level studies

(e.g., Tschardt et al., 2008; Wanger et al., 2010; Qie et al., 2011), and the examination of social policy issues with a bearing on the conservation and functioning of tropical forests (Lohman et al., 2007; Koh et al., 2008; Koh and Sodhi, 2010; Bawa et al., 2011). Navjot focused these individual pieces of the conservation puzzle in several books about elements of tropical biodiversity under threat (Sodhi and Brook, 2006; Sodhi et al., 2011), or more general writings about conservation in a tropical setting (Sodhi et al., 2007, 2008).

It might be surprising to some that even though his academic training occurred in India (B.Sc. and M.Sc. at Panjab University) (Bradshaw et al., 2011), Navjot's early research career was in fact based in Canada (a decidedly non-tropical country). As part of Lynn Oliphant's lab at the University of Saskatchewan (where IGW met Navjot) studying an urban-based population of merlins (*Falco columbarius*), he wrote a series of papers about merlin breeding

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biology and behaviour (e.g., Sodhi et al., 1990, 1992; Sodhi, 1991) as well as the original and subsequently revised accounts of this species in *Birds of North America* (Sodhi et al., 1993; Warkentin et al., 2005). Navjot extended his boreal experience through post-doctoral work with Cindy Paszkowski at the University of Alberta on the habitat use and breeding biology of warblers living in fragmented forest systems (Sodhi and Paszkowski, 1995; Sodhi and Paszkowski, 1997; Sodhi et al., 1999). It was there where as a student, CJAB met Navjot for the first time.

An emerging theme in Navjot's recent initiatives was a renewed interest in boreal issues. It had become clear to us (Bradshaw et al., 2009) that, despite the enormous potential for the boreal forest to affect global climate change through its influence on carbon dynamics (Pan et al., 2011), this home to nearly half of the world's remaining tracts of large, intact forest (Potapov et al., 2008) was, for the most part, being ignored by global policy makers. In a perverse twist of science focus and policy advocacy, the previously under-studied and under-appreciated plight of the tropics had stolen the conservation movement's attention. Ironically, it has always been the case that much more conservation research is done in temperate biomes (e.g., North America, Europe, southern Australia) (Sodhi et al., 2007), yet arguably now the global flagships for much of conservation science and advocacy are mainly tropical (e.g., Amazonian deforestation, biodiversity loss, palm oil expansion in Southeast Asia) (Brook and Bradshaw, this volume; Edwards and Laurance, this volume; Shearman et al., this volume). Despite the substantial knowledge base available on northern ecosystems relative to their tropical counterparts, the world seems largely to have overlooked the conservation issues facing the second 'lung' of the planet – the boreal forest of North America, Scandinavia and Russia (accepting that the first 'lung' is the Amazon).

With his previous experience working in boreal ecosystems and following his maturation as a conservation scientist in the tropics, Navjot planned to return to his roots and apply his finely honed craft to the boreal region. So strong was his conviction that immediately prior to his death, he had accepted a professorial chair at the University of Toronto and was poised to make the move to Canada in late 2011 (Bradshaw et al., 2011). While by no means did he intend to abandon his tropical interests, he felt strongly that more focus and attention was necessary to prevent the boreal forest ecosystem from undergoing the same widespread conversion of native forest cover, fragmentation and associated loss of biodiversity that has recently been seen in most tropical ecosystems.

The call made by our 2009 review published in *Trends in Ecology and Evolution* (Bradshaw et al., 2009) was for a greater understanding of how best to manage the boreal third of the world's forest cover (representing about 50% of the world's remaining tracts of large, intact forest). Navjot's intention was to emphasise the need to reduce the negative influences of rising threats from fire and fragmentation because he was certain that these factors could have catastrophic consequences for carbon stored (about one third of all carbon sequestered by forests worldwide) and biodiversity sheltered within the boreal forest system. As we pointed out in the review, the entirety of the boreal forest is becoming increasingly fragmented with ecologically contiguous patches constituting only 44% of its entire area. Ever watchful for the linkages among environmental economics, policy, and conservation (Grainger et al., 2009; Laurance et al., 2010; Sodhi et al., 2010), Navjot suggested (Warkentin and Sodhi, 2008) that conservation programs in the developed world of the boreal nations could be both an inspiration for conservation initiatives in the tropics, and a source of funding to sponsor greater conservation action in those countries through Reduced Emissions from Deforestation and forest Degradation (REDD) programs.

Our recommendations for improving boreal forest management (Bradshaw et al., 2009), originating in part from Navjot's extensive

experience in the tropics, can be summarised in four points. (i) The rapid climate-warming signal already evident in boreal regions (Ruckstuhl et al., 2008) requires forest management planning over much broader time scales, and the incorporation of predictions about shifts in ecosystem dynamics and species distribution, which currently they do not. This implies emulating not only current natural disturbance regimes in forestry practices, but anticipating their change as fire frequency and severity intensify in response to rapid climate warming (Achard et al., 2008). (ii) More extensive reserve systems in the boreal biome, especially in Russia and Canada, should be established based on the essential role that these vast tracks of forest play in carbon sequestration (Luyssaert et al., 2008). This includes a concerted effort to minimise fragmentation by maximising connectivity between existing and future reserve systems. (iii) Existing and new reserves should be large enough to accommodate natural disturbance regimes (mainly fire) that provide niches for an array of habitat-specialist species (Berg et al., 1994). (iv) More promotion of broad-scale reforestation is required to combat the massive deforestation and fragmentation, particularly in Russia (Achard et al., 2006). Although these general principles are likely to guide responsible forest management in the future, there is still a great need for research to identify the best methods for achieving these aims. It is a shame that Navjot will not be a contributor to these research endeavours; the efforts will be poorer without him.

One such research program that is, however, starting to elucidate the complex relationships between natural fire regimes, timber harvest management and silvicultural approaches to forest restoration is the Ecosystem Management Emulating Natural Disturbance (EMEND) project based in the boreal mixedwood forest near Peace River, Alberta, Canada ([www.emend.rr.ualberta.ca](http://www.emend.rr.ualberta.ca)). EMEND is a broad-scale (10-ha, 99 experimental units), variable-retention harvest experiment ( $4 \times 8$  factorial) designed to examine the effects of residual forest structure on ecosystem integrity and forest regeneration at the stand-level. EMEND began operations in 1998 after completing pre-manipulation baseline assessments of stand structure and biodiversity, and is forecast to run for approximately 80–100 years to emulate the stand rotation typical of forestry operations in that region. Despite its genesis over a decade ago, preliminary results are only just starting to emerge. For example, Work et al. (2004) determined that coarse-filter management of mixedwood boreal forests must incorporate structural features beyond overstory canopy composition through variable-retention harvesting. Surveys of nearly 27,000 arthropods from 230 species demonstrated that with adequate recovery following first harvest, and maintenance of microhabitat features, similar patterns of biodiversity arose between old-growth and older (~30 years) post-harvest blocks (Buddle et al., 2006). Patriquin and Barclay (2003) found that timber harvesting designs that create patch mosaics of different tree densities will protect a wider diversity of microchiropteran bat species than a system leaving less-diverse patch types, although harvest type appears to have little effect on soil nutrient profiles (Jerabkova et al., 2006). Results from a number of taxa measured under EMEND show that succession is a critical issue for conservation planning in the boreal forest. Under retention harvest regimes, we can expect rapid recovery of species from early seral stages; however, effective conservation of species associated with more advanced successional stages will likely require effective landscape-level planning for location and linkage of residual patches (e.g., Work et al., 2010). Such long-term experiments are invaluable for establishing the most sustainable harvesting regimes, but much more needs to be done to account for how these relationships will be altered in a rapidly warming climate. Clearly, the time to develop management strategies to cope with these looming changes is limited for both boreal and tropical systems (Corlett, this volume). However, EMEND represents the

type of approach espoused by Lindenmayer and Laurence (this volume) as a means to evaluate both the broad spatial and long temporal influences of climate change on forest harvest management decisions.

Navjot always enjoyed poking a stick in the eye of conventional thought, and not always to the pleasure of some of his colleagues (Bradshaw et al., 2011). We believe that his planned move to Canada in 2012 to work at the University of Toronto would have represented a much-needed boost for evidence-based policy shifts to slow and possibly reverse the worrying trends now evident in the boreal region (Bradshaw et al., 2009). His calculated meddling in the *mêlée* of boreal forest-related politics (see Bickford et al., this volume) would likely have provided a more authentic and yet impassioned call to arms for what has been, to date, a muted chorus of concern about the value of this ecosystem to northern nations and to the world. Not that we believe he would have forsaken his support of the clear need for continued action in the conservation of tropical systems; rather, his shifted attention to the north signalled a re-direction of his efforts towards the somewhat unconventional notion that the role of the boreal forest must be championed as well. We concur with this sentiment and implore our colleagues and their students to follow in his well-intentioned, albeit unrealised, footsteps.

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