Update

Letters

# Planning forwards: biodiversity research and monitoring systems for better management

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The world is currently facing a suite of complex and dynamic issues that threaten the diversity and processes sustaining humanity. Ecologists have long debated how to best study these issues, resulting in 'friendly fire' between different camps of thought. The most recent casualties, the Alberta Biodiversity Monitoring Institute (http://www.abmi.ca), and the PPBio Program in Brazil (http://ppbio.inpa.gov.br/Eng/public/) and Australia (http://www.griffith.edu.au/ppbio), results from Lindenmayer and Likens' [1] supposition that these programs lack rigorous questions, a factor that has 'undermined the credibility of long-term research and monitoring'. We believe that Lindenmayer and Likens' [1] misinterpretation of the goals of these programs is perpetuating a false dichotomy between traditional research and innovative programs such as the ABMI and PPBio. This division undermines collaborative research between the two approaches and could impede understanding of long-term ecological patterns and processes. It is now time to resolve this issue because the number of countries initiating similar programs is increasing, and now includes Australia, Canada, New Zealand, Sweden, Switzerland and the USA. Here, we explain the two main reasons for our concern.

First, traditional stand-alone studies (even exceptional examples such as the Hubbard Brook Experimental Forest [1] or the North American Waterfowl Management Program [2]) cannot address all biodiversity needs. Many of the questions that need answering focus on how the cumulative effects of multiple human stressors lead to biodiversity change [3]. The common response to this complex question is to amalgamate data from existing research and small-scale short-term monitoring in meta-analyses, or to monitor habitat change through remote sensing as a coarse-filter proxy. Both of these solutions have well-described limitations [4]. An innovative approach is needed that fosters cooperation to answer multi-scale management-relevant questions [4,5]. Recognizing this, countries increasingly are investing in long-term ecological research and monitoring (LTER) systems, such as the ABMI and PPBio. These systems facilitate multidisciplinary multi-scale research and monitoring over extended periods and are designed to address current and future biodiversity questions [6].

What characterizes a good LTER system? Although space prohibits a detailed explanation of these systems, here we highlight some important commonalities and related advantages (e.g. Refs [4,5,7]). LTER systems are designed to track ecosystem change at scales that are appropriate to management (hundreds to thousands of kilometers) over many decades to reveal how biodiversity responds to landscape and global changes. These systems use modular, systematic designs and standardized methods, emphasize rigorous unbiased sampling designs, and invest in human resources, field sites, data storage and data dissemination. They integrate data from many taxa and ecological processes (e.g. Refs [7,8]). The information collected at each location aids local management and can be synthesized at regional, national and global levels. LTER systems are designed to operate across generations of scientists rather than relying on the commitment of a few individuals. Monitoring systems take advantage of existing gradients, both environmental and stressor related, to address questions nested within their overarching goal. The systems retain statistical power even as these gradients change over time, and also generate original, high-quality research (e.g. http://ppbio.inpa.gov.br/Eng/public/ and http://www.abmi.ca/abmi/reports/reports.jsp?categoryId=63).

This leads to our second concern: despite their obvious advantages for studying and monitoring broad-scale biodiversity change, LTER systems are being misinterpreted [1,2,9]. For example, Lindenmayer and Likens suggest that the ABMI and PPBio have been 'planned backwards, in a collect data now, ask questions later' manner [1]. In reality, these programs strive to plan forwards, and are driven by broad but important questions, such as how biodiversity changes in time and space in response to changing human activities. As new issues and questions arise, scientists can use monitoring system data to answer these questions, similar to the adaptive monitoring approach proposed by Lindenmayer and Likens [1]. Systems such as ABMI and PPBio successfully meet the seven features of successful LTER systems as presented by Lindenmayer and Likens [1], providing comparable data and metadata for cost-effective biodiversity management.

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In summary, LTER systems can provide a standardized infrastructure to collect comparable data to answer the questions of today, and a rigorous scientific basis to address future challenges. We invite scientists to integrate stand-alone studies within innovative LTER approaches to provide future generations with the management tools to move beyond the confines of our current limited biodiversity knowledge.

## References

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