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## Forest Biodiversity and the Delivery of Ecosystem Goods and Services: Translating Science into Policy

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# Forest Biodiversity and the Delivery of Ecosystem Goods and Services: Translating Science into Policy

IAN D. THOMPSON, KIMIKO OKABE, JASON M. TYLIANAKIS, PUSHPAM KUMAR, ECKEHARD G. BROCKERHOFF, NANCY A. SCHELLHORN, JOHN A. PARROTTA, AND ROBERT NASI

*Biodiversity is integral to almost all ecosystem processes, with some species playing key functional roles that are essential for maintaining the value of ecosystems to humans. However, many ecosystem services remain nonvalued, and decisionmakers rarely consider biodiversity in policy development, in part because the relationships between biodiversity and the provision of ecosystem services are not generally appreciated. To date, the majority of work in which the functional importance of biodiversity has been examined has been conducted in relatively species-poor systems. Focusing on forest and agroforest systems, we synthesize recent research on the role of biodiversity in the provision of ecosystem services and provide examples of biodiversity science that informs ecosystem management and policy. Finally, we highlight barriers to the transfer of knowledge from scientists to decisionmakers and suggest that scientists can be much more effective at informing policy and improving resource management by asking policy-relevant questions and providing timely and consistent information to decisionmakers and the public on the linkages among biodiversity, ecosystem services, and their value to people.*

**Keywords:** ecosystem services, valuation, biodiversity, forest management, natural resources policy

**B**iodiversity—diversity within and among species—is related to the production of most ecosystem services (e.g., Hooper et al. 2005, Balvanera et al. 2006). For example, biodiversity underpins a wide variety of goods and services provided by forest and agroforest ecosystems, including the prevention of soil erosion, pest control, pollination, clean water, food, climate change mitigation, control of disease vectors, and local ecosystem resilience and stability (table 1). When ecosystems are managed for only a limited set of goods and services, such as timber from forests (e.g., Nasi and Frost 2009), many other ecosystem services may be overlooked and therefore undervalued. Although the ecology research agenda for understanding biodiversity effects on ecosystem services is relatively clear (Kremen 2005), translating the growing body of research results into policy advice is a major challenge (e.g., Perrins et al. 2011).

If ecosystems are to be effectively managed and conserved, the value of all ecosystem services, including the externalized costs of their loss, needs to be understood by decisionmakers. A key role for science is to refine our understanding of how ecosystems function, to establish the links between functions and the provision of ecosystem services, and then to communicate that knowledge effectively to decisionmakers

and the public. Illustrating the importance of biodiversity for ecosystem goods and services valued by people is an increasingly important contemporary approach to influencing conservation policy and complements other arguments for biodiversity conservation.

The multiple interconnections among species in complex ecosystems can result in redundancy within functional groups with key roles for some species (e.g., Diaz and Cabido 2001). The precise effects of this complexity on many ecosystem functions, especially during periods of environmental change, need to be understood if we are to maintain the provision of all of the goods and services that people require. These issues are particularly relevant to intensively managed forest and agroforest ecosystems, which are usually characterized by low levels of biodiversity relative to natural forests (Brockerhoff et al. 2008). For example, the extent to which plantation forests can provide a wide range of ecosystem goods and services is becoming increasingly relevant, as the global area of plantations expands, while that of natural forests continues to decline at a rate of about 13 million hectares (ha) per year (FAO 2010).

In the present article, we examine some of the known complexities in quantifying functions in forest and agroforest ecosystems, discuss examples of how some of this

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Abstract:

Biodiversity is integral to almost all ecosystem processes, with some species playing key functional roles that are essential for maintaining the value of ecosystems to humans. However, many ecosystem services remain nonvalued, and decisionmakers rarely consider biodiversity in policy development, in part because the relationships between biodiversity and the provision of ecosystem services are not generally appreciated. To date, the majority of work in which the functional importance of biodiversity has been examined has been conducted in relatively species-poor systems. Focusing on forest and agroforest systems, we synthesize recent research on the role of biodiversity in the provision of ecosystem services and provide examples of biodiversity science that informs ecosystem management and policy. Finally, we highlight barriers to the transfer of knowledge from scientists to decisionmakers and suggest that scientists can be much more effective at informing policy and improving resource management by asking policy-relevant questions and providing timely and consistent information to decisionmakers and the public on the linkages among biodiversity, ecosystem services, and their value to people.

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