Foreword

The Challenge of Ecological Restoration

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Recent estimates by the World Conservation Union (IUCN) and World Resources Institute (WRI) suggest that over 2 billion ha of forests are degraded and in need of restoration. Goren Persson, former prime minister of Sweden, proposed the formation of a Global Restoration council to implement the Bonn Challenge to restore 150 million ha of degraded forests by 2020. The importance of forest land cover to climate change mitigation is reflected in international efforts to Reduce Emissions from Deforestation and Degradation (REDD+) of tropical forests, while at the same time enhancing biodiversity and other conservation goals. In accepting the importance of restoring degraded forests, the scientific community must respond with approaches informed by defensible concepts of what defines a forest, what is the threshold between acceptable (because it is somehow natural) disturbance and degradation, and how should current restoration goals be altered to accommodate future climates?

Restoration ecology is a science only recently emerging from practical, site-specific attempts to reverse the effects of degradation. Explicit in much literature (and most guidelines) is the premise that ecological restoration means a return to conditions matching a reference site, a non-disturbed "natural" condition. Practitioners within the restoration ecology community and other resource professionals have challenged the notion of naturalness as an objective. The crux of the debate is whether naturalness represents a scientifically defensible concept or is simply a statement of a preference for one kind of ecosystem or another.

Crucial to the debate are the starting and ending points, and a practitioner's perception of the extent of human influence in a forested ecosystem, both in the past and the uncertain future. What constitutes successful restoration is defined within a cultural and ecological context that also determines what constitutes degradation. Understanding the effects of past disturbances and the likelihood of future disturbances is critical to designing appropriate restoration techniques, but disturbance ecologists typically focus only on natural disturbance regimes, eschewing human-caused degradation. This ignores that forests today are human-dominated systems. Global ecosystems have been altered by anthropogenic activity to an extent unprecedented in the historic record. Land cover changes such as deforestation and wetland conversion, river channelization and damming, and soil erosion are just some of the overt drivers of change leading to loss or diminishment of species, ecosystem functions, and quality of life.

Added to the muddle of when does disturbance become degradation and what is the appropriate goal for restoring degraded forests is the challenge from climate variability and future climate change; how to set the balance between rebuilding past ecosystems and building resilient systems for the future. The effect of climate variability on forested ecosystem processes and disturbances (both biotic and abiotic) is uncertain, adding to the complexity caused by our imperfect understanding of these relationships under today's climate. Most climate change work looks at effects of changing mean conditions between now and some future date as if there will be a gradual, albeit rapid change of mean conditions to which species will react. However, one of the salient features of climate change will be more extreme events with greater year-to-year variation in weather. More intense or frequent extreme events are likely to occur sooner than changes in climatic means, increasing the need for restoration. The short-term forecast, therefore, is for increases in degraded forests in spite of restoration efforts. In fact, some restoration that seeks a return to former conditions may result in further degradation.

Anticipating future conditions and planning adaptive responses will be more complex than simulating increases in temperature and decreases in precipitation and seeking current communities adapted to future conditions. Critical changes will affect limiting conditions for regeneration, pest and disturbance dynamics. Native and non-native species will invade new habitat or change competitive relations. Changed conditions will cause effects at variable rates and over a range of scales, complicating strategies for responding especially in regions of mixed land ownerships. Because species within a forest ecosystem will respond individually to radical shifts in local climate, the resulting novel ecosystems will be comprised of species assemblages without current analogs. These novel ecosystems may be transient with shifts in species dominance driven by continued climate variability. Further, the social responses to climate change/variability are

unpredictable and will vary according to the "social capacity" of individual societies.

How are we to respond? First, we can recognize that setting restoration goals is essentially a social (i.e., political) process that can be informed, but not determined, by ecological understanding. Second, we should recognize that our understanding of past, current, and future environments is limited and likely incomplete, therefore subject to change. Third, with humility we must accept that decisions taken today likely will be seen as wrong by future generations. Our challenge is to devise strategies that are robust; they must be highly likely to result in good outcomes even if they are not optimal. Additionally, these strategies should be adaptive and allow for corrective actions in the future. The ultimate goals for restoration ecologists are to provide managers with guidelines for setting appropriate restoration objectives within a given social context and state of ecological understanding and to provide them with reliable techniques for restoring sustainable forest ecosystems that are robust in the face of climate variability and change and that continue to meet human needs for commodities, ecosystem services, and spiritual reflection.

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