

## Forest Restoration: Simple Concept, Complex Process

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To begin discussing forest restoration, we must answer the question “what is a forest?” The most basic definition is that a forest is an ecosystem that is dominated by trees. The Convention on Biological Diversity calls a forest an area of greater than 0.5 ha with a tree canopy cover of more than 10% and where the area is not under non-forest land use (such as agriculture) [1]. Similarly, for the USDA (United States Department of Agriculture) Forest Service Forest Inventory and Analysis (FIA), the definition of forest land is at least 0.5 ha and is at least 10% stocked by trees of any size, including land that formerly had tree cover and that will be naturally or artificially regenerated [2]. In relation to these definitions about forest restoration, we define a forest as a non-agricultural ecosystem of greater 0.5 ha that is dominated by trees that yield greater than 10% canopy cover. Unlike the FIA definition, we do not consider an area that was once treed to be a forest, although, through restoration, it has the potential to become a forest.

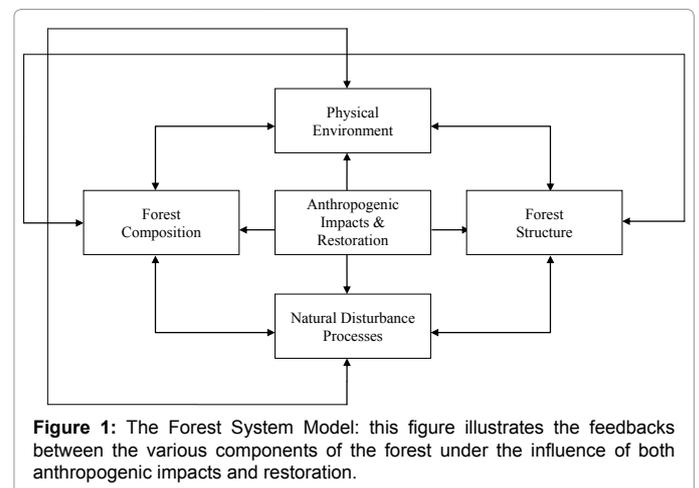
The second question we must ask ourselves is “which forests need to be restored and why?” Forests that need to be restored are those that have been degraded, destroyed, or removed by human activity. The concept of forest restoration is simple: fix what we broke. Through policies and actions, people have messed up. We took natural forest systems and attempted to use and control them for our own purposes. Now that we have realized the damage we have done, we want to set things back in place. We want to fix our mistakes and bandage up the wound we inflicted, hoping that in time it will heal. We created a problem through overuse and by issuing policies without a sound understanding of natural systems, and now we want to fix that problem by using policies and science under the same philosophy which got us here, “that we can control natural processes”.

The third question to answer is “what is restoration?” Perhaps, the only universal covering law regarding forest restoration is that the restoration of forests is complex. Early restorationists sought to restore forest composition and structure to some point in the observable past. Most contemporary restoration, however, focuses on restoring ecological processes. In some cases, such as with a completely denuded landscape, a combination of the two may be warranted [3].

In answering these three questions, forest restoration seems conceptually simple. However, the reality is that the process of restoration involves an intricate feedback process (Figure 1). Restoration of forests works by the same forces and on the same components as negative anthropogenic impacts, but with the goal of restoring forest health. Anthropogenic impacts create effects of forest structure and composition, the underlying physical environment, and natural disturbances. Likewise restoration also affects these four key components of the forest system [4]. However, the real trick is that each of these components is also affecting all the other components. Therefore, the forest practitioner must keep in mind the totality of the effect of restoration on the forest system. The species planted, the patterns in which they are planted, the disturbance processes that are introduced or suppressed, and any mechanical changes to the physical environment will all have feedbacks to the other areas and therefore cannot be considered in isolation.

The main counterargument here comes in two forms. First, it is not possible to consider all potential complex interactions at all scales. This statement is true. There are simply too many processes operating at too many levels with too much stochasticity to fully understand all those interactions. However, we believe that considering the major processes and interactions on a macro-scale is better than ignoring system complexity because it is too complex. The second major argument will be that while it is worthwhile to theorize about the nature of forest restoration as we have presented it, it is not practical due to temporal, economic, and perhaps political constraints. Again, if these ideas are enacted at the macro-scale, and with the idea that we cannot incorporate every detail, it is just a matter of making adequate attempts in restoration planning to consider potential feedbacks. Modeling is the best tool we have available to make those considerations.

Forest restoration, while seemingly a simple concept, must be conceptualized and enacted through the lens of complexity. The best way to do this is through modeling. However, models must continually develop and expand to incorporate ecosystem complexity while meeting the needs of forest practitioners in a practical and user-friendly way. Open Access journals, such as Forest Research, are an important way to begin this process because all stakeholders have access to the research and ideas being published there. Only by considering the complexity of the forest system will we be able to create sustainable restoration plans.



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Received January 09, 2013; Accepted January 10, 2013; Published January 13, 2013

Citation: Waldron JD, Xi WM (2013) Forest Restoration: Simple Concept, Complex Process. Forest Res 2:e104. doi:10.4172/2168-9776.1000e104

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**Citation:** Waldron JD, Xi WM (2013) Forest Restoration: Simple Concept, Complex Process. Forest Res 2: e104. doi:[10.4172/2168-9776.1000e104](https://doi.org/10.4172/2168-9776.1000e104)

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