To Emulate Natural Forest Disturbance or Not?

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The emergence of emulating natural forest disturbance (ENFD) as a forest management paradigm has caused resource managers to ask many questions about its appropriateness and associated mechanisms. We provide an overview of the logic behind ENFD including a working definition, and highlight some aspects of its practice and future.

When is it appropriate to emulate natural disturbance in forestry?

Emulating natural disturbance as a forest management approach is suited for ecosystems that are disturbance-driven; for example, fire-driven boreal forests, fire-driven montane forest savannas, and flood plain forests. These ecosystems are expected to be inherently resilient to periodic disturbance and are able to adapt and recover (Figure 1). Here *resilience* implies the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes and persist (Holling 1973).

Our working definition for ENFD is: *Emulating natural disturbance is an approach in which forest managers develop and apply specific management strategies and practices, at appropriate spatial and temporal scales, with the goal of producing forest ecosystems as structurally and functionally similar as possible to the ecosystems that would result from natural disturbances, and that incorporate the spatial, temporal, and random variability intrinsic to natural systems* (from Perera and Buse, in press). Based on this definition, the scale of possible management approaches associated with emulating natural disturbance ranges from just using disturbance outcomes as a general guide for management to letting natural disturbances proceed without intervention.

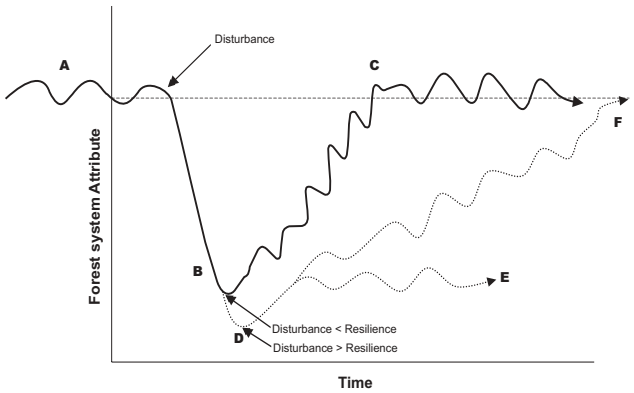

Figure 1. *A conceptual illustration of how a forest ecosystem might respond to disturbance (from Perera and Buse, in press).*

How could natural disturbance be emulated?

By understanding natural disturbances

To successfully emulate natural disturbance requires a sound understanding of the natural disturbances common to the managed landscape (e.g., type of disturbance, its spatial and temporal scale, its frequency and intensity, and its interactions with other disturbances).

By adopting a template

Forest practitioners need to adopt a disturbance template as a guide for emulating natural disturbance by forest management. Following are examples of potential templates (as described in Perera et al., in press).

1. The landscape pattern created by the *last* major disturbance. In this approach managers attempt to recreate the last known natural disturbance, implicitly assuming that natural disturbances are spatially and temporally constant, and will always create identical patterns.

2. Historical landscape pattern that has resulted from a *series* of previous natural disturbances (one common benchmark is the pre-European settlement period), assuming that the inferred

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landscape patterns are the net result of a series of prior natural disturbances, and that what *did* happen is a good indication of the intrinsic potential of natural disturbance regimes (i.e., of what *will* happen).

3. A broad temporal span of the historical evidence, following the same deductive logic as the previous one, but which captures the *variability* associated with disturbance regimes (known as the historical range of variability).

4. Historical templates derived through simulation modelling of historical scenarios. The philosophy resembles those of the first three approaches, but templates are constructed with inductive reasoning.

5. Spatially explicit simulation modelling of the *potential* natural disturbance regimes (i.e., modeling of scenarios). This inductive method differs from the other four in that it focuses on what *could* happen without referring to historical conditions. Although this approach has the disadvantages of being ethereal and abstract, simulating these scenarios has the advantages of capturing both the empirical and the mechanistic variability that are innate to natural disturbance regimes and of being spatially explicit.

By developing emulation criteria

Practitioners must develop a suite of emulation criteria to parallel the attributes of the selected disturbance(s) (Table 1). In doing this, it is critical that the management scale and disturbance attributes be matched appropriately and the effects or outcome of the disturbance(s) be carefully considered.

By clarifying management approach

Since ENFD will not replicate a natural disturbance, it is critical to clarify and match the extent and degree to which management will emulate disturbance with expectations; and communicate these clearly to all involved. For example, the proposed approach can be

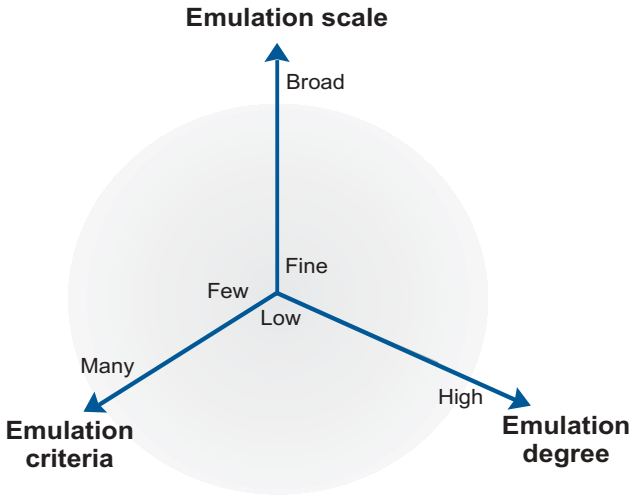

Figure 2. *A simplified ordination scheme for practices designed to emulate natural disturbance considering dimensions of scale, number of criteria, and degree (from Perera et al., in press).*

illustrated using an ordination diagram (Figure 2) to ensure that stakeholders are clear about the scale, criteria, and degree of planned ENFD.

By monitoring outcome compared to disturbance in nature

As with any other management approach, in order to determine whether the planned outcome was accomplished and allow for future improvements the outcome of natural disturbance emulation must be monitored and evaluated. This involves deciding at the outset what system attributes will be monitored and how monitoring will be accomplished. For example, the outcomes of management decisions could be assessed based on the principles in Figure 1. Then the emulation scale, criteria, and degree would be adapted accordingly for future interventions.

What's left to ponder?

As with any emerging management paradigm, many questions remain to be answered. For example: Do we understand the disturbances? (E.g., do we understand the patterns and are we able to predict consequences in space and time? Do we know how different disturbances interact?); Are the goals and expectations of

Table 1. *Examples of disturbance attributes and emulation criteria for developing strategies that emulate natural disturbance (from Perera and Buse, in press).*

Nature of disturbance	Overall rate of disturbance for a large region and its variation	Fire-return interval, annual rate of defoliation
	Spatial tendency of disturbance and its variation	Spatial probability of wind damage, burns, floods
	Temporal patterns in disturbance and its variation	Interval between fires, insect epidemics, floods
	Intensity of disturbance and its variation	Severity of fire or defoliation and their spatial and temporal patterns
	Geometry of disturbance	Sizes, shapes, and adjacency of patches of disturbance
Consequences of disturbance	Spatial and temporal patterns in landscape composition	Patterns in residual vegetation, post-disturbance succession
	Spatial and temporal patterns in landscape age structure	Patterns in age-class distribution, species--age patterns
	Ecological processes	Nutrient, carbon, and hydrological dynamics

emulation clear to all stakeholders? (E.g., do they understand the potential outcomes of the proposed management approach? Can the goals be successfully communicated to all involved?); Is this approach socially acceptable? (E.g, is it compatible with cultural, aesthetic and other values? Is it acceptable to emulate nature through management?); Is this approach economically feasible? (E.g., how will this approach affect short and long-term timber supply? Is it cost-effective relative to current management practices?)

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