DEFINITIONS:
FULLY FUNCTIONING FOREST ECOSYSTEMS
AND ASSOCIATED CONCEPTS

Maintaining healthy, sustainable human societies and economies requires the maintenance of fully functioning ecosystems. Brief definitions, based on the scientific literature, of "fully functioning forest ecosystem" and associated concepts are provided below. These definitions are of value to people developing and applying processes for forest use planning.

These definitions draw on the concepts of Landscape Ecology. Ecologists now understand that individual landscape patches (also often called ecosystem types) do not exist in isolation. Activities and changes in any patch affect other patches in the landscape. As Forman and Godron state in their 1986 text Landscape Ecology:

> Landscape ecology explores how a heterogeneous combination of ecosystems is structured, function and changes. From wilderness to urban landscapes, our focus is on (a) the distribution patterns of landscape elements or ecosystems; (b) the flows of animals, plants, energy, mineral nutrients and water among these elements; and (c) the ecological changes in the landscape mosaic over time.

The definitions in this document are interrelated by the concepts of landscape ecology. No one definition should be considered or discussed in isolation from the others.

Fully Functioning Forest Ecosystem

Maintaining a fully functioning forest ecosystem is the foundation for truly sustainable use of the forest. Healthy, sustainable economies and societies are based on maintaining the integrity of the ecosystems from which resources are obtained. Even if we do not understand exactly how a forest ecosystem works, it is still important to keep all the parts in the system and to retain the energy, nutrient, and biotic flows within and between the various parts of the ecosystem.

This understanding leads to an important general definition for a fully functioning forest:

Maintaining a fully functioning forest ecosystem requires maintaining the full natural range of ecological functions at both the stand and landscape levels.

In order to maintain forest ecosystem functions, change and disturbance must remain a part of landscape dynamics. Disturbance and temporal progression of forests is a natural, continuous ecological process. Suppressing or preventing natural disturbance in ecosystems, e.g. fire, has had unexpected and undesirable ecological effects. Increasing the intensity, frequency, and/or characteristics of disturbance, e.g. clearcutting, can also have significant detrimental effects.

"Maintaining ecological functions" is a lofty goal, and one which is difficult to quantify given humans' lack of knowledge of ecosystem processes. However, rather than focus on poorly understood processes, we can protect and maintain the physical structures which support, and the biological communities or ecosystem composition which manage ecological functions. For a "stand level" example, protecting structures such as large standing snags maintains habitat for woodpeckers and other cavity nesting birds, which contribute to ecosystem function by helping to control insect populations. As another stand level example, maintaining the biological community of forested riparian zones will help to maintain streambed morphology, terrestrial and aquatic nutrient cycling, and aquatic ecosystem health over the short and long terms. When we retain natural structures and species composition in managed lands, we take positive steps to maintain ecological functions.

People can benefit from the existence of natural disturbance cycles. Activities such as ecologically responsible timber cutting match human resource uses with ecosystem cycles. However, important forest structures and biological communities must be retained during logging in order to provide for essential ecological processes through the life of the forest stand. While ecologically responsible timber extraction occurs at the stand level, a functioning forest landscape must also be maintained to provide source populations and viable access routes for organisms associated with all forest temporal phases.

Maintaining stand level ecological structures, composition, and functions in isolation is not sufficient. Approximately natural spatial arrangements and proportions of the full range of ecosystem types and temporal phases of ecosystem types must be maintained within the forest landscape. Natural spatial patterns and functions range from the microscopic world of the forest soil community to the landscape levels of large watersheds. Temporal patterns and functions in a forest range from early successional to old growth phases. Both the nature of the components of the natural spatial pattern, and the connections between spatial components, are important parameters.

A fully functioning forest ecosystem requires that human disturbances of any sort must be carried out in ways that ensure the protection of natural structure, composition, and function at the stand level, while also ensuring the maintenance of natural spatial and temporal patterns across the landscape. Simply having set aside protected areas is not sufficient - ecological processes across the forest landscape must be maintained. Retaining ecological functions, or the structures to support functions, is required at all locations.

Stand Level

The stand level of forest use refers to the ecosystem scale where a relatively homogeneous forest unit can be identified. The composition, structure, and ecological functions within a stand are similar enough that an ecologically responsible forest use prescription can be applied uniformly within the stand, without encountering changes in ecological parameters which are sufficient to produce unexpected or undesirable results. This applied definition relates the physical size of "a stand" to the artificial criteria of the plan and/or assessment being used. In the past, "stands" have largely been defined by narrow timber characteristics driven by short-term economic variables. However, to maintain functioning forests at the stand and landscape levels, stands must be defined by ecosystem factors necessary to maintain fully functioning systems. This contradiction between timber management and ecologically responsible forest use is inherent in ecologically responsible approaches. Field ecosystem parameters related to natural disturbance patterns and movement patterns (i.e. energy, nutrients, water, and animals) determine stand size and scale, not rigid or desired criteria.

Synonyms for *stand* include *ecosystem type* and *patch*.

Landscape Level

The landscape level of forest use is based on the concepts of landscape ecology. A landscape is a mosaic of interconnected, interdependent stands or patches which are repeated in a pattern across the larger landscape. For purposes of human use, landscape level decisions are made for watersheds of small (less that 5,000 hectares) to moderate size (5,000-50,000 hectares). In regional planning processes, landscape level considerations expand into watersheds which encompass hundreds of thousands of hectares.

Scale At Stand And Landscape Levels

Scale is an important consideration when defining both stand and landscape level terminology, and when planning and carrying out activities to ensure the maintenance of a fully functioning forest ecosystem. The effects and level of ecological processes vary with scale. A forest may appear inactive with few functions at a human scale. However, at a smaller scale, myriad soil organisms are active, and at a larger scale energy flows shape the forest landscape. The scale of an assessment affects the results of research and the level of impacts of any given disturbance. The "answer" to any question pertaining to landscape structure or function usually depends on the scale of observation.

Depending on the object of study, the physical definitions of stand and landscape differ greatly. What is a homogeneous, well-connected environment to a moose may be patchy and fragmented to a mouse. While we generally define "stand" and "landscape" at a human scale, to suit our biases as human beings, landscape management to maintain natural ecological processes requires that we consider <u>all</u> scales in our activities. Human perceptions must not establish de facto boundaries or compartments in a wholistic system that has no compartments or boundaries.

Even with high quality planning and responsible, informed operators, any human disturbance will create less favorable or unfavorable conditions for some organisms. Our challenge is to ensure that such change does not equate to degradation, meaning that organisms which are required after disturbance, or which are necessary to recolonize an area following disturbance, do not become locally, regionally, or globally extinct.

Degraded Forest Stand

A degraded forest stand has suffered damage to natural composition, structures, and functions such that population levels and diversity of organisms have been changed in an unnatural manner. Degradation also occurs if structures required for ecological processes and populations in later temporal phases have been removed, and/or will not be regenerated due to human disturbance. The ability of a degraded patch to sustain appropriate levels of biotic activity, and to play necessary roles in the larger landscape, has been impaired.

Stand level degradation commonly occurs when some organisms in a forest stand are given priority over other organisms or parts of the stand during human use. For example, a forest stand may be degraded if, in the process of cutting and managing trees for timber, other organisms and forest structures are removed or disturbed, while only the trees are replaced. One must remember that many organisms, such as soil microorganisms, cannot be replaced.

Natural systems make use of redundancy - many ecosystem functions can be performed by more than one species or process. Humans have often reduced or eliminated these fallback mechanisms through land use practices which deplete soil, aquatic, and/or terrestrial biodiversity. While loss of diversity and loss of ecosystem redundancy may have no immediate visible effects, we believe that it is profoundly unwise to casually discard ecological redundancy as a "cost of doing business". Long-term ecosystem stability is compromised. We thus regard unnatural loss of biodiversity and ecological redundancy as a form of stand level degradation.

Landscape Level Degradation

Three principles of landscape ecology in temperate forests are germane to this discussion:

1. Disturbance and renewal are constant in forest ecosystems.
2. Forest structure and composition vary over time.
3. Not all forest organisms can persist in any one habitat type at any one time.

Maintaining forest landscapes, or preventing landscape degradation, does not mean an end to disturbance and an attempted imposition of stasis. This would itself be utterly unnatural and ecologically degrading. Change equates to stress and dynamic shifts in populations and energy and nutrient fluxes within the landscape. If human created disturbances exceed the tolerance of species adapted to natural disturbance cycles, degradation has occurred.

In order to maintain ecological functions, we must maintain viable populations of forest organisms, from soil microbes and fungi to large carnivores. Maintaining viable populations in changing landscape requires that each species must have sufficient suitable

habitat for population persistence and must be able to move between habitat areas to colonize suitable habitats which develop over time.

Degradation of the landscape occurs when natural spatial and temporal patterns of a landscape are not maintained. Well-recognized forest components such as intact riparian ecosystems and cross-valley connecting corridors are necessary to ensure landscape level forest functioning. As well, temporal or successional phases must be maintained in relatively natural proportions across the landscape. Thus, modifying forest landscapes once dominated by old growth or late successional forests so that they are now dominated by early successional and young forests constitutes severe landscape level degradation. Another common example of landscape level degradation is breaking connections across the landscape by logging riparian ecosystems and cross-valley connecting corridors.

As disturbance is a required natural process, landscapes can be modified by logging and other human uses, provided that:

1. Sensitive sites are protected and landscape connections are maintained by means of a protected landscape network of riparian ecosystems and cross- valley connecting corridors.

2. Successional patterns in logged areas are maintained. Both early successional shrub/herb and late successional old growth forest phases must be included in the landscape; the landscape cannot be homogenized such that 80% of the forest is closed canopy, young forest in the 20- to 100-year age class.

3. Old growth structures are maintained in the managed forest during and following logging, and provisions are made to continue to provide old growth structures in the following and subsequent rotations.

Avoiding landscape level degradation requires long timeframes (250 to 500 years) in forest use planning, and consideration of spatial arrangements of ecosystem types or landscape patches across large areas (20,000 to 50,000 hectares at a minimum).

Active inventory and planning are required to estimate the patterns and distribution of forest patches in a functioning landscape, and to ensure that an ecologically viable network of habitat types remains after human use of the forest. Acceptance of stand level plans without consideration of the effects of all planned resource development over time will lead to damaged and degraded forest landscapes.

Conventional assessment of logging plans provides an example of short-sighted landscape planning. A five-year logging development plan is an explicit plan of logging in the near future. Land managers respond to the activities outlined, often requesting modifications to protect wildlife habitat, fisheries values, or biodiversity. However, the implicit long-term forest use plan, as defined by the annual allowable cut, is often not addressed. The current AAC often calls for cutting all economically accessible forested areas in one 80- to 100-year rotation. This will result in eradication of old growth habitat types from the general landscape, in reduction of structural diversity, and in simplification of biological communities at the stand level.