



## LANDSCAPE ECOLOGY

### FOREST STEWARDSHIP MANAGEMENT NOTE #39

#### WHAT IS A LANDSCAPE?



1. DEFINITION - In the field of landscape ecology, a landscape is defined as a heterogeneous land area composed of interacting ecosystems that are intermingled in a similar pattern throughout (#8).

2. VISUALIZATION - An easy way to understand this definition is to imagine looking down at the ground from an airplane. From a plane you can see a repeating pattern of farms, woodlands, wetlands, lakes, towns, and roads. Keep watching and before long you will notice a change in the character of the mosaic below as you cross into a different landscape.

3. STRUCTURAL COMPONENTS - The structure of a landscape is determined by the proportions and spatial arrangement of three main elements:

MATRIX - the land type that is most connected, forming the background on which other elements appear to be placed.

PATCHES - islands of land types that differ from the matrix.

CORRIDORS/BARRIERS - Narrow strips that connect or separate similar patches.

4. EXAMPLE - For example, in an agricultural landscape, the matrix consists of fields and the patches consist of woodlots and towns. Corridors would be represented by rivers and fencerows connecting woodlots and roads connecting towns.

5. SIZE - Landscapes are larger than stands and smaller than regions. Their size is quite variable, but as a rule-of-thumb they range from a few thousand acres to a thousand square miles or more (#14). Thus, from a private landowner's viewpoint, a landscape perspective means considering factors far beyond the property boundaries.

#### WHAT IS LANDSCAPE ECOLOGY?

Landscape ecology is an applied science that tries to understand how the structure of landscapes influence their functions as ecological systems through time. Thus, questions are asked according to three interrelated approaches (#7).

1. STRUCTURAL APPROACH - How are landscape elements spatially arranged? What sizes, shapes, and patterns of intermixing are found among the matrix, the patches, and the corridors?

2. FUNCTIONAL APPROACH - How does the spatial structure of the landscape influence the flow of energy, matter, and organisms across the landscape? The flow of organisms includes both the movement of individuals and fluctuations in population sizes.

3. TEMPORAL APPROACH - How did the current landscape patterns come about, how are they likely to change, and how will these changes influence landscape functions.

#### WHY IS A LANDSCAPE PERSPECTIVE IMPORTANT?

In short, a landscape perspective is important because many problems cannot be solved by piecemeal actions on small land areas.

1. WILDLIFE MANAGEMENT - Landowners who want to manage for large or mobile species need to take landscape structure into account because such animals are likely to spend significant parts of their lives on

other properties. Thus, in order to provide good habitat conditions, it is first necessary to know what kinds of habitats are available on adjacent lands and then to provide the limiting habitat types.

2. BIODIVERSITY - Landowners with a stewardship ethic recognize their responsibility to help maintain the overall biodiversity of their region (FSMN #35,37). Maintaining biodiversity depends on a maintaining a diversity of habitat types and ages at the landscape level but maximizing habitat diversity on a small property can actually reduce regional species diversity (#15, FSMN #37).

Dividing a block of relatively uniform habitat into two or more different habitat types will generally increase the diversity of wildlife species, but will reduce habitat for regionally rare, "area-sensitive species" that require large, unbroken blocks of the original habitat type (#17). For example, a drastic decline of area-sensitive bird species has occurred in landscapes where formerly extensive forests are heavily fragmented (#4,6).

3. WATER RESOURCE CONSERVATION - A land stewardship ethic also requires landowners to take responsibility for the effects of their actions on downstream water quality. The only way that the cumulative effects of soil erosion, and other non-point sources of pollution, can be controlled is through a land stewardship ethic that includes a landscape perspective.

4. ECONOMIC PRODUCTIVITY - Just as maintaining a diversity of habitat types across the landscape is necessary to maintain viable wildlife populations (#2), maintaining a diversity of forest types and ages within rural communities provides consistent employment in silvicultural operations, manufacture of forest products, and non-timber forest products and services (#16). Landscapes that are too uniform with regard to forest products are subject to undesirable boom and bust economies.

## **INCLUDING LANDSCAPE FACTORS IN LAND MANAGEMENT PLANS**

Comprehensive application of landscape ecology principles (#5) is difficult on most private, non-industrial forests because landowners usually control only a tiny fraction the landscape. Nevertheless, it is wise to plan management actions within the context of the surrounding landscape. As a rule-of-thumb, one should be familiar with a land area about 10 times the size of the property under consideration (#3). Following is a suggested procedure for including landscape level factors into land management plans (#7).

1. FIXED FEATURES - First, map spatially fixed features that require protection, such as:

- SPECIAL AREAS - Places where rare species, archaeological sites, unusual geological formations, etc. occur.
- LARGE NATURAL PATCHES - Large blocks of relatively undisturbed habitat have high value for area-sensitive species (see above, #7).
- CORRIDORS AND OTHER FLOW AREAS - Areas where the movements of animals, people, water, soil, etc. are concentrated.
- BARRIERS - Areas where the movements of animals, people, water, soil, etc. are restricted.

2. NEEDED CONNECTIONS - Second, tie the above fixed features together by planning and mapping:

- ADDITIONAL LARGE PATCHES - These may be needed to expand existing patches to an effective size.
- ADDITIONAL CORRIDORS/BARRIERS - These may be needed to facilitate/block movements of organisms among isolated patches or to facilitate management activities.

3. MANAGEMENT UNITS - Third, after the basic framework has been established, shift the focus to management plans for individual areas in two steps.

- VEGETATION UNITS - Divide the entire property into vegetation units, based on existing plant community types and ages.
- MANAGEMENT UNITS - Decide whether any of the vegetation units should be subdivided or combined. For example, part of an old field might be planted to conifers for winter wildlife cover. Divide the vegetation units into management units based on the type(s) of management practices that are planned for them.

4. FINE-SCALE LAYOUT - Finally, decide the detailed layout of management units' boundaries and roads. Consideration should be given to how the spatial arrangement will affect all the landowner's goals and objectives (FSMN #34).

### **SOME LANDSCAPE CONSIDERATIONS FOR TIMBER MANAGEMENT**

1. ASSESS NEARBY STANDS - Before making timber management decisions, inspect nearby timber stands and/or plantations for problems or desirable conditions. To the degree that neighboring stands have similar vegetation and soils, and their management history can be determined, they provide excellent indicators of what can be expected in the area. For example, if an adjacent plantation shows heavy browsing, it would be wise to consider planting a more browse-resistant species, delay planting until browsing pressure declines, or employ tree protection methods.

2. DIVERSIFY TIMBER SPECIES - Timber prices are, to some degree, determined by supply and demand. Thus, other factors being equal, it is advantageous to favor species that are in low supply in the landscape and region. Diversifying the timber species produced in relation to the species dominating the landscape also guards against losses to pests and diseases (#12).

### **SOME LANDSCAPE CONSIDERATIONS FOR WILDLIFE MANAGEMENT**

1. COMPLEMENT SURROUNDING HABITATS - Comparing the availability of habitat types in the surrounding landscape with the mix of habitats needed by the target species is a fundamental to wildlife habitat improvement (#3). For example, if the landscape surrounding a property contains little winter cover, harvesting the only conifer stand on the property would be disastrous for wildlife. On the other hand, if winter cover dominates the landscape, and is unlikely to be harvested, cutting conifers to stimulate browse could be sensible.

Converting stands from one habitat type to another or subdividing them into multiple habitat types is one of the principal tools of landscape management. Deciding the best mix of habitat types and ages and their spatial arrangement is a complex task, requiring detailed knowledge of the target species' habitat relationships (#12).

2. PROVIDE CORRIDORS - Corridors that allow animals to safely move across inhospitable parts of the landscape are important for dispersal of young and recolonization of isolated habitat patches. Thus, landowners should strive to maintain, restore, or create such corridors, especially along natural dispersal routes such as streams (#2).

3. PROVIDE CRITICAL HABITAT COMPONENTS - Some critical habitat components, such as traditional nesting trees or vernal ponds (FSMN #30) occupy small areas. By protecting such sites, landowners enhance wildlife populations over large areas. Where stream habitat is present, landowners can go beyond their basic responsibility to protect water quality by managing riparian woodlands in ways that will enhance fish populations (#10, FSMN #31).

## LAND MANAGEMENT ACROSS OWNERSHIPS

Forest management at the landscape level does not mean that all landowners must adopt the same management objectives or be controlled by a central bureaucracy. Diversity of objectives and approaches is crucial to the social acceptability of ecosystem management at the landscape level (FSMN #36). However, voluntary coordination of some management practices across ownerships could mutually enhance both environmental and economic benefits.

### 1. TIMBER MANAGEMENT

- **ACCESS ROADS** - For best economic and environmental performance, access roads should not be constrained by property boundaries (FSMN #5). Cooperation among landowners could go a long way toward the development of roads that are located on suitable slopes and soils. Similarly, unauthorized use that damages soil and water or disturbs wildlife could be better controlled by cooperatively managing roads.
- **HARVESTS** - Timber harvesting opportunities can also be enhanced by working with nearby landowners, either by combining jobs or by avoiding conflicting jobs.

### 2. WILDLIFE MANAGEMENT

Healthy populations of most wildlife species depend on the availability of suitable habitat over landscape-sized, or larger areas (FSMN #40). Many species range over large areas, and those that move little are subject to local extinctions and must be restored by dispersal from nearby populations. Thus, maintaining well-connected matrix habitats and abundant corridors among patch habitats is a goal that requires cooperation among all landowners.

**MINIMIZE FRAGMENTATION** - Where forest fragmentation is a problem, landowners can jointly retain large blocks of undisturbed timber for as long as possible by locating harvests next to other recent harvests. Cuts can be increased in size without causing problems if they are kept narrow and broken up by leaving live trees and buffering corridors (#13, FSMN #28).

**MAINTAIN CORRIDORS** - Because corridors are linear features, they cross many property boundaries, and because they are narrow, they are vulnerable to destruction by uninformed landowners. Establishing relatively undisturbed riparian buffer zones (FSMN #5) will protect corridors along wetlands and water bodies, but upland corridors among woodlots can also greatly enhance wildlife populations (#1, 11, FSMN #9).

## REFERENCES

FSMN #'s refer to other Forest Stewardship Management Notes in this series.

- #1 Barrett, G.W. and P.J. Bohlen. 1991. Landscape ecology. Chapter 9 in Reference #8.
- #2 Crow, T.R., et al. 1993. Report of the scientific roundtable on biological diversity. USDA Forest Service TP-R9-CNF/NNFÄ 93-1.
- #3 DeGraaf, R.M., et al. 1992. New England wildlife: management of forested habitats. USDA Forest Service GTR NE-144.
- #4 DeGraaf, R.M. and W.M. Healy (compilers). 1990. Is forest fragmentation a management issue in the Northeast? USDA Forest Service GTR NE-140.
- #5 Diaz, Nancy and Dean Apostol. 1992. Forest landscape analysis and design. USDA Forest Service Pacific NW Region R6 ECO-TP-043-92.
- #6 Faaborg, J., et al. 1993. Habitat fragmentation in the temperate zone: a perspective for managers. Pages 331-338 in D.M. Finch and P.W. Stangel (eds.) Status and management of Neotropical migratory birds. USDA Forest Service GTR RM-229.
- #7 Forman, R.T.T. 1990. Landscape ecology plans for managing forests. Pages 27-32 in Reference #4.
- #8 Forman, R.T.T. and M. Godron. 1986. Landscape ecology. Wiley and Sons.

- #9 Freemark, K.E., et al. 1993. Pages 346-352 in D.M. Finch and P.W. Stangel (eds.) Status and management of Neotropical migratory birds. USDA Forest Service GTR RM-229.
- #10 Hollingsworth, R.W. 1990. Fish habitat and forest fragmentation. Pages 19-22 in Reference #4.
- #11 Hudson, W.E. (ed.). 1991. Landscape linkages and biodiversity. Island Press.
- #12 Hunter, M.L. 1990. Wildlife, forests, and forestry. Principles of managing forests for biological diversity. Prentice Hall.
- #13 Mladenoff, D.J. and J. Pastor. 1993. Sustainable forest ecosystems in the northern hardwood and conifer forest region: concepts and management. Chapter 5 in G.H. Aplet, et al. (eds.) Defining sustainable forestry. Island Press.
- #14 Norris, L.A., et al. 1993. Task force report on sustaining long-term forest health and productivity. Society of American Foresters 93-02.
- #15 Noss, R.F. 1983. A regional landscape approach to maintain diversity. BioScience 33(11):700-706.
- #16 Oliver, C.D. 1992. A landscape approach. Achieving and maintaining biodiversity and economic productivity. Journal of Forestry, September 1992.
- #17 Robinson, S.K. 1988. Reappraisal of the costs and benefits of habitat heterogeneity for nongame wildlife. Pages 145-155 in Transactions of the 53rd North American Wildlife and Natural Resources Conference.
- #18 Risser, P.G., et al. 1984. Landscape ecology - directions and approaches. Illinois Natural History Survey Special Publication No. 2.

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