



Vittorio Ingegnoli

Landscape Ecology: A Widening Foundation



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With 127 Figures



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DR. VITTORIO INGEGNOLI

Professor by Contract of Landscape Ecology

University of Milan

Department of Biology

Via Celoria 26

20133 Milan

Italy

e-mail: vingegnoli@iol.it

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Figure 1



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Dedicated to Elena, my Wife

Foreword

Exactly 25 years ago on a warm autumn afternoon a young ecologist walked slowly through a tiny oak wood, and perched on a log to reflect. He had measured and seemingly knew “all” the species present - trees, mosses, mushrooms, birds and more. The research, based on this and other woods in the landscape, was the first rigorous test to see if island biogeographic theory was of use in heterogeneous land. Unexpectedly, an interior-to-edge model was found to be more useful. But on this beautiful sunny day he gazed out through the trees at the surrounding bean and maize fields.

Suddenly a terrible thought hit him. The land surrounding the other woods differed slightly from this scene. Here there were two bean fields plus a maize field, meadow, hedgerow and farm road, but the other comparably sized woods studied had different mixes of these land uses. Wouldn't the surroundings seriously affect the species in the woods? Had he done “bad science” (an awful feeling for a scientist)? Immediately he went to all his ecology books, searching for discussions of patchiness, mosaic pattern, interactions between ecosystems, and the like. Nothing. Surprise was a new ingredient to ponder. Then for 3 months every spare moment found him in the university library digging deeper, collecting tidbits and clues. A new feeling took over, challenge and excitement. The spatial arrangement of ecosystems and land uses is important ecologically! A giant but approachable scholarly frontier. Furthermore, a sense emerged that solutions to most environmental issues lay within the frontier.

Events then cascaded. Research led to publication of a patch-corridor-matrix model in 1979. He met like-minded researchers and spoke at a 1981 Dutch conference on landscape ecology, a term he had never heard, yet one with a nice ring. In 1983 landscape ecology was introduced to North America at an Illinois conference he and colleagues organized. As the field accelerated thereafter its diverse roots and foundations became clearer. Especially important were the widely known geography-vegetation traditions in Germany, spatial animal-movement-habitat studies in The Netherlands and in Australia, diverse land planning and evaluation approaches in Europe and the Mediterranean Region, hedgerow network studies in Canada, and patch-corridor-matrix, pattern-process-change, island biogeography and spatial modeling of heterogeneous landscapes across the USA.

These roots led to extensive research and abundant literature centered around the ecology of landscapes. Modern landscape ecology, with a highly useful body

of theory and principles, is the result. With leading figures worldwide, the field is growing rapidly and today embraces a richness of perspectives, which provide hybrid vigor.

Into this dynamic field arrives the wonderful book in your hand written by Vittorio Ingegnoli. This is the seventh landscape-ecology book on my shelf authored or edited by Sandro Pignatti, Almo Farina, and Dr. Ingegnoli, all leaders in Italian landscape ecology. These books reveal a richness of theory, perceptive syntheses, many useful Italian and worldwide applications, and distinct areas where Italian research leads the way. Perhaps only Australia and the USA rival Italy in the number of valuable landscape-ecology books available.

I am the ecologist who perched on a log, and am not only an admirer of this Italian work, but also have learned much from Italian landscapes. As a child I ran around the Ponte Vecchio, liked Giotto, wondered where Dante got his information, and explored from the Alps (where my uncle served just before World War I) to Taormina (where my aunt is buried). Much later, my workshop-seminars in Florence for students and professionals were followed, in turn, by publishing a landscape-ecology article in Italian, doing transects to the most remote spots in Venice, and receiving a Università degli Studi di Firenze medal and honorary membership in the Società Italiana di Ecologia del Paesaggio. Although I have published on the spatial patterns produced by different processes, from atop a tower in San Gimignano, Dr. Ingegnoli taught me a new pattern, the distinctive stable fine-scale result of centuries of trial-and-error by rural landowners in Europe and elsewhere.

Every landscape ecologist will appreciate what Vittorio Ingegnoli has done for us in this book. The diverse European and North American approaches and perspectives have finally coalesced. An amazingly rich palette of methods, both for analytic understanding and to evaluate landscapes for appropriate land uses, is lucidly revealed. An impressively wide range of theories and simple useful equations for landscape ecology is laid out. A promising approach to understand landscape "pathology" or degradation is introduced. Nice new case-study applications in Italy, Africa, and across Europe are presented. The "widening foundation", whereby landscape-ecology principles are increasingly used in fields related to land use, is illustrated from urban planning and conservation biology to agricultural land and economic/ecological sustainability. Modern landscape ecology has come a long way in a short time.

Yet opportunities abound for even more rapid progress in this "Decade of Landscape Ecology". I see three groups of opportunities.

First, the *significant gaps* in today's landscape ecology include: (a) ecological flows across the land; (b) adjacencies and neighborhood configurations; (c) stream/river corridor width and design; (d) cluster of small patches versus a corridor for species movement; (e) importance of plants and vegetation in landscape ecology; (f) ecologically optimum network forms; and (g) the roles of spatial patterns produced by nature, planning/design, and lack thereof.

Second, *new frontiers* evolve naturally from landscape ecology. (a) "Spatially meshing nature and culture" is of unparalleled importance, but remains shrouded. (b) In contrast, "road ecology" is emerging with clear focal areas, such as traffic

disturbance/noise effects on natural communities, the road-effect zone, development of theory, and meshing ecological flows and biological diversity with safe and efficient transport.

Third, we *the people* highlights how landscape ecologists might work. Begin by considering the change from how we spend our time to how we get (and got) our inspiration. Also, look beyond our colorful land-use-and-ownership models to see the key fine-scale attributes of a landscape, such as little-road systems, hedgerow habitats, groundwater flows, and human paths and animal routes across heterogeneous land. Make sure that both solid long-half-life empirical insight and promising short-half-life quantitative models move forward arm in arm. Spend more time with colleagues in landscapes outside one's own continent. Write rather than edit concise books on landscape ecology, its major areas and applications. Outline visions for the future, in addition to improvements for the present. Indeed, imagine landscape ecology at the end of the decade.

In conclusion, one does not have to be a "rocket ecologist" to see that society is wasting land. Unplanned suburbanization rampages across the land. Houses "grow" on good agricultural soil in a world with hungry bellies. Increasingly, busy highways degrade nature in wide swaths across the land.

Yet, in spots, we actually see landscape ecology principles being used for solutions, reversing the trend of wasting land. Will these spots grow in number and size? Certainly. And coalesce? Hopefully. The science and applications of landscape ecology will be at the heart of success. Indeed, this book, *Landscape Ecology: A Widening Foundation*, is well named. All students and problem-solvers concerned with changing land should carefully absorb its pages.

Harvard University,
November 2001

Richard T. T. Forman

Preface

Some twenty years after the foundation of the IALE (International Association for Landscape Ecology), during the Fifth World Congress (1999 - Snowmass Village, Colorado), President John Wiens noted that the variety of topics and approaches represented in the literature testifies to the diversity of landscape ecology as a discipline. This diversity is at once the great strength and the potential weakness of landscape ecology. In fact, different research traditions and cultures have been brought to landscape ecology through different ways.

At present, if we compare the main topics of landscape ecology, we can recognise four principal disciplinary models: (1) geographical, (2) chorological, (3) matrix configured, (4) holistic. The first model is closely associated with the interrelation between natural and human components, from the point of view of geomorphology, botany, architecture, etc., and has been led by geography toward an interdisciplinary science. The second model is rooted in population ecology and zoology, driven by the need to develop spatial characters and scale processes in general ecology. The third disciplinary model is related to the attempt to study the ecology of land ecosystems. The last model derives from an holistic view, dealing with landscapes as open, adaptive, dissipative, self-transcendent systems of natural and human elements. Therefore, each point of view defines the landscape in a different manner.

At the same time, the urgent need for a sustainable environment has made landscape ecology increasingly accepted by the policy makers of nature conservation and restoration and of territorial planning. But what should landscape ecology be? Is it an interdisciplinary method necessary to study the environment on a landscape scale? Or, is it a level of biological organisation? And, how does the inseparability of landscape and culture affect the contents of this discipline?

There is no doubt that the above mentioned problems require a widening foundation of landscape ecology in order to reach a manifold but unique definition of landscape and to recognise what is important about landscapes.

I agree with Richard Forman: it is important to start from the solid scientific and spatial foundations of landscape ecology. If that is done, then applications related to the land can go in any direction: sustainability, biological conservation, territorial planning, etc. If landscape ecology principles can be unified to create a cultural ecological utopia, that is fine, but it can not be a confused one, since that suggests that the scientific and spatial principles have been inadequately used or understood. In this framework, trying to converge towards such a unification

seems to be very difficult. In my opinion it is necessary to arrive at a new disciplinary model capable of utilising and integrating the best of all the others. The basis of this integration is not impossible, if we give a widening foundation to our discipline, in which correct epistemological references, linked to the new scientific paradigms and a more adequate ecological theory, permit the complex self-organising system that we call landscape to be studied in a way that could be available to respond to the challenge of sustainable development and biological conservation.

The following main steps seem to be necessary to reach the integration: (1) to specify that the landscape, as a system of biogeocoenosis (Forman and Godron 1986), is a *proper biological system*, enhancing that even culture does not implicate the subjection of nature to the dominance of man. As a matter of fact the distinction between a living being and his environment has no substantial significance. (2) Given that a landscape is much more than a set of spatial heterogeneous characters, to specify the *intrinsic biological* characters of the landscape (structural and dynamic) as being different from the *exportable* characters (mainly chorological). (3) Remembering the expressions of Forman and Naveh, who mentioned the “interweaving of the ecosystems in a landscape”, to refer to a new, more complex structural model, based on the concept of tissue, which could be named *ecotissue* (Ingegnoli 1999). Actually, all the other disciplinary models present their spatial schemes based on the concept of mosaic. But in this way it is impossible to integrate completely their differences. Finally, (4) to consider landscape ecology as a discipline like medicine, *biologically based* but *transdisciplinary*. In fact, since the landscape is a biological system, it is the physiology(ecology)/pathology ratio which permits a clinical diagnosis of a landscape.

Moreover, we have to note that a discipline of landscape ecology with a wider basis may arrive to change many principles of traditional ecology, especially vegetation science, leading to a unified ecology. If vegetation science remains principally based on phytosociology, neglecting the underlying principle of order and allowing an endless analysis (Pignatti 1998), it makes every attempt at synthesis difficult. The main objective of vegetation science must concern description, synthesis and *diagnosis* of the complex adaptive system of vegetation. For this purpose, it is necessary to integrate the floristic description, biodiversity and synecology analyses, following the holistic, unifying landscape ecological approach.

Section I of this book develops the *theoretical principles* concerning all that has been mentioned above, trying to demonstrate the possibility of widening our discipline. In doing this, it will be possible to clarify the relationships among landscape ecology, landscape sciences and their applications.

Section II of this book is related to the question of a proper *methodology* of landscape study. In fact, any application needs a correct analysis and evaluation of the landscape (or of some parts of it) together with a good diagnostic phase. In coherence with the first section's principles, new ecological indexes are presented, like the BTC (Biological Territorial Capacity), which is a quantity able to express the level of complexity and the capacity of self re-equilibrium of a vegetation

ecotope. Moreover, it is generally necessary to control the results using these landscape ecological indexes and comparing this information with the characters derived from other scales. As in medicine, the environmental evaluation needs comparisons with “normal” patterns of behaviour of a system of ecosystems. Therefore, the main problem becomes how to recognise the normal state of an ecological system, and/or how to identify the levels of alteration of that system, which may threaten human health, even in the absence of pollution.

Strictly linked to methodology are the applications. The main three chapters of landscape ecological applications are synthesised in: (1) environmental sustainability, (2) biological conservation, (3) environmental design and territorial planning. In *environmental sustainability* - at present - every ecological system is defined as an ecosystem, generating an ambiguous and limiting reference; that is why, at a recent scientific meeting of German and Italian ecologists at the German Congress Center Villa Vigoni (Lake Como, 1999 - chairman Wolfgang Haber and Sandro Pignatti), my working group underlined the importance of healthy natural and cultural landscapes among the major goals for sustainable development. In *biological conservation* the need for landscape ecology was so strong as to be one of its founding disciplines; for example, biodiversity has to be intended not only as α , β , γ , (*sensu* Whittaker) but also as landscape biodiversity. In *environmental design and territorial planning* the main question remains how to design with nature: landscape ecological principles and methods must be added to the traditional ones. In the interaction between urbanisation and surrounding landscapes the need for new methodological criteria becomes crucial, especially because the most of the human population in the biosphere is going to live in urban and suburban landscapes.

In conclusion, I hope that this book will be of interest to a broad audience in suggesting a new disciplinary perspective in landscape ecology and to create new professionals, such as environmental physicians, because the challenge of sustainability is a continuous one.

Milan, October 2001

Vittorio Ingegnoli

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