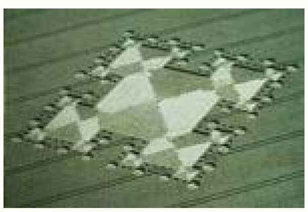
Symposium: Spatial Ecology

November 22, 2002



Spatial Ecology is a hot topic in ecology. Population dynamics, resource exploitation, ecosystem stability, and many other fundamental properties of natural systems are predicted to be qualitatively different by spatially explicit models as compared to non-spatial, classical models. Empirical support for spatially-explicit concepts seems to lag behind, however, and it is unclear to many ecologists whether spatial considerations really matter for their work.

This symposium is intended to be an eye-opener on spatial ecology for a relatively broad public of ecologists-at-large, including people working in more applied areas such as nature conservation. The prime aim of our symposium is to consider a critical question at a conceptual, empirical and also applied level: Are spatial structures worth taking into account in my studies, in my work? And if so: why and what are the conclusions I should reckon with? The contributors will not stress the technical aspects of their work, but rather discuss if and how these more complicated approaches (both theoretical and empirical) lead to qualitatively different conclusions compared to simpler approaches that assume a homogeneous world. They address the question if it has been worthwhile to devote all this time and energy to spatial aspects of ecological interactions. Have some of the old paradigms been changed forever? Will spatial ecology increase our capacity to confront ecological problems that are bound to result from future loss of biodiversity or global change?

Organisation

Organisation:
Peter Herman and Johan van de Koppel,
Spatial Ecology department, NIOO-CEME, Yerseke, and
Han Olff, Plant Ecology, RUG Groningen.
Logistics: Marieke Bootsma, Netherlands Institute of Ecology.

Advice and overview: Hans de Kroon

For practical questions:
currentthemes@nioo.knaw.nl

This symposium is sponsered by the Royal Ducth Academie of Sciences.

Location of the Spatial Ecology Symposium

Date: November 22, 2002
Venue: WICC, Wageningen The Netherlands
Admission, including lunch: € 15,= (Students & PhDs: € 10,=, Necov members € 2,= reduction)
Starting time: 9.30 hrs.
Registration: currentthemes@nioo.knaw.nl

Address and route to the Wageningen International Conference Centre (WICC).

Programme

Print version

09.30-10.00	Registration and coffee
10.00-10.40	**Prof.Dr. Simon A. Levin** (Princeton University, USA): Traveling in space
10.40-11.20	**Dr. Johan van de Koppel and Dr. Max Rietkerk** (NIOO-CEME and Utrecht University): The importance of being pretty: Spatial self-organisation in ecosystems
11.20-12.00	**Prof.Dr. Jacques C.J. Nihoul** (University of Liège, Belgium): Scale breaks and scaling relations in physical-ecological modelling of the ocean processes
12.00-13.00	Lunch
13.00-13.40	**Dr. P.E. Schmid** (Queen Mary, Univeristy of London, UK): Fractal properties of benthic ecosystems: methods and applications.
13.40-14.20	**Prof.Dr. Han Olff** (University of Groningen, The Netherlands): Interactions between biodiversity and the spatial structure of the environment
14.20-15.00	**Dr. Peter Stoll** (University of Basel, Switserland): Testing spatial ecology: some thoughts based on empirical evidence from plants
15.00-15.30	Tea
15.30-16.10	**Prof.Dr. Paul Opdam** (Alterra/Wageningen University, The Netherlands): Ecological networks: applying metapopulation ecology in nature conservation and landscape planning
16.10-16.50	**Prof.Dr. André De Roos** (University of Amsterdam, The Netherlands): Pretty patterns, obscure origins? Synthesis of a day on Spatial Ecology
17.00	End

Traveling in space

Simon A. Levin

Moffett Professor of Biology, Department of Ecology and Evolutionary Biology, Princeton University, USA. Email: slevin@princeton.edu.

Click here to see Simon Levin's Hompage.

Much ecological theory and practice is associated with biodiversity- what it means, what maintains it, and how to sustain it. Still, the most basic ecological theories are concerned with exclusion and extinction, and the limits to coexistence. Those classical theories are largely set in homogeneous environments, and spatial variation, exogenous and endogenous, changes the basic conclusions. In this lecture, I will discuss the role of underlying heterogeneity and patchiness in maintaining biodiversity. In laymen's terms, I will review mathematical approaches, and their implications for coexistence, pattern formation and invasion biology. I will talk about problems of pattern formation and multiple stable states, trying to set the stage for other presentations. I will also explore evolutionary aspects, and also importance to reserve design. I will conclude with a discussion of the evolution of ecosystems and the biosphere as complex adaptive systems, and implications for resiliency.

Close this window

The importance of being pretty!
Spatial self-organization in ecosystems.

Dr. Johan van de Koppel and Dr. Max Rietkerk

1: Netherlands Institute of Ecology, PO Box 140, 4400 AC Yerseke, The Netherlands.
Email: j.vdkoppel@nioo.knaw.nl. Click to see Johan van de Koppel's homepage.

2: Utrecht University, Dept Environmental Sciences, P.O. Box 80115, 3508 TC Utrecht, The Netherlands. Email: m.rietkerk@geog.uu.nl . Click to see Max Rietkerk's homepage.

Positive feedback has been identified as a possible cause of catastrophic shifts between ecosystem states. Recent studies furthermore show that ecosystems with strong positive feedback may exhibit distinct spatial patterns, resulting from spatial self-organization. These patterns are found, for example, in arid grasslands, peatlands and intertidal mudflats. A unifying principle may explain these patterns across different ecosystems: scale-related differences in facilitating and competitive interactions between organisms. Theoretical models suggest that spatial interactions that form the basis of these patterns buffer against catastrophic ecosystem shifts, and increase the productivity of ecosystems. Therefore, it is important to integrate spatial scale into ecological theory and to determine the validity of such theory with further empirical studies.

Close this window

Scale breaks and scaling relations in physical-ecological modelling of the ocean processes.

Prof.Dr. Jacques C.J. Nihoul

GeoHydrodynamics and Environment Research, University of Liège, EU. Email: J.Nihoul@ulg.ac.be. Click to see Prof. Nihoul's Homepage.

The construction of interdisciplinary three-dimensional models of the marine system is discussed emphasizing (i) the natural variability of the ocean where physical and biogeochemical processes of all time and length scales cohabit and interact, (ii) the existence of spectral windows corresponding to scales of external forcings, eigenmodes of oscillations and information channels and to hierarchical levels of ecological and biochemical organization, (iii) the necessity of developing an assemblage of nested models, each of which is focused on a definite spectral window and takes advantage of larger scale models to determine the initial and boundary conditions set by the long term trend and reach and of smaller scale models to parameterize the non-linear residual effect of the sub-window scale fluctuations.
Operant state variables are defined by their nature but also by their length scale, time scale and hierarchical position in the iogeochemical/ecological web. Appropriate evolution equations are established and the formulation of flows, fluxes and local production/destruction rates are discussed.
The perspective of applying 3D nested interdisciplinary models for the evaluation of sustainable development scenarios is stressed and their present and essential role in focusing sets of fuzzy data and clearing the data base which will be needed for model forecasts is emphasized.

Close this window

Fractal properties of benthic ecosystems: methods and applications.

Dr. P.E. Schmid.

Queen Mary, University of London, Mile End Rd, London E1 4NS, UK. Email: P.E.Schmid@qmul.ac.uk.

Fractal geometry provides both a mathematical model and description for quantitatively characterising complex structures and processes in nature. Ecological patterns and many of their inherent processes display a simplifying invariance under changes of scale. This statistical self-similarity or self-affinity essentially characterises the fractal dimension, which is used as simple index demonstrating a relationship between the measuring scale and the attribute of spatiotemporal process-pattern interactions being measured.

This presentation will include applications of scaling and self-similarity in the field of spatial ecology ranging from landscape and habitat structures to aspects of species diversity and species-size distributions of invertebrate communities. Because methods to estimate the fractal dimension have often been applied in an uncritical manner violating assumptions about the nature of fractal structures, methodological aspects and their interpretation will introduce some case studies.

Close this window

Interactions between biodiversity and the spatial structure of the environment.

Prof. Dr. Han Olff.

Plant Ecology, University of Groningen, Kerklaan 30, 9751 NN Haren, The Netherlands.
Tel: +31 50 3632214, E-mail: H.Olff@biol.rug.nl

Abstract under development

Close this window

Testing spatial ecology: some thoughts based on empirical evidence from plants

Dr. Peter Stoll

Department of Integrative Biology, Section of Conservation Biology, University of Basel, St. Johanns-Vorstadt 10, CH-4056 Basel, Switzerland. E-mail: peter.stoll@unibas.ch. Tel: ++41/61/267 08 56; fax ..08 32. Click to see Peter Stoll's hompage.

Space and other environmental resources are generally limited. Therefore, competitive interactions between individuals of the same and different species are inevitable and may lead to competitive exclusion. Non spatial theory tells us that species coexist only if competition between individuals of the same species is stronger than competition among individuals of different species.
In contrast, spatial theory tells us that there need not be such species specific differences in order for species to coexist. If the spatial pattern is aggregated or clumped, such that individuals of the same species meet more often than individuals of different species, then competitive exclusion can be slowed down and coexistence maintained.

In my presentation, I will summarise the few competition experiments with plants that took spatial patterns explicitly into account. I will also give a more detailed example of an experiment with four annual weed species planted in random or aggregated spatial patterns. The experimental data support predictions from spatial competition models that aggregation within species may promote coexistence by slowing down competitive exclusion. This implies that the spatial arrangement of plants in a community can indeed be an important determinant of species coexistence and biodiversity.

Close this window

Ecological networks: applying metapopulation ecology in nature conservation and landscape planning.

Prof.Dr. Paul Opdam

WUR-Alterra, Landscape center, P.O. Box 47, 6700 AA Wageningen, The Netherlands, p.f.m.opdam@alterra.wag-ur.nl Tel: +31 (0) 317 477943

While spatial ecology aims at understanding how populations and communities respond to spatial heterogeneity and scale, landscape ecology seeks to understand how landscapes function and develop, including man as part of the landscape. Landscape ecology is basically a problem-oriented science, integrating geography, ecology and social sciences. A landscape is conceptualized as a high-order ecological system, an assembly of ecosystems interacting by spatial flows of water, matter and organisms. Man is part of that landscape: using natural resources for economical functions and for well being, and developing the landscape to meet his needs. Hence, landscapes are also the object of planning; a social process aiming at spatially optimizing the configuration of ecosystems for the various types of land use functions. This is the stage where biodiversity conservation plays an increasingly important role.

Nature conservation is currently developing from a reserve-oriented to a landscape-oriented approach, under the influence of emerging principles of landscape ecology and spatial ecology. In particular in parts of the world where land use by man dominates the landscape pattern, and many natural habitats are fragmented, conservationists begin to realize that many species depend on the amount and spatial configuration of habitat and the landscape matrix in which the habitat is embedded. Metapopulation ecology offers a theoretical base for this paradigm shift. It learns that local nature management might not be effective if the spatial conditions are insufficient, but also that local impact may have a regional effect. It also learns that absence in suitable habitat may indicate a fragmentation problem, implying instability at the local level, but not necessarily at the network level.

In its spatially explicit form, the metapopulation theory is one of the fundaments in landscape ecology. In the last decade, ecological networks have become a strong planning concept, allowing nature conservation to play a role in landscape development. However, there is still a wide gap between knowledge of how populations respond to landscape heterogeneity and its application in spatial planning. That is because most metapopulation research stops after statistics revealed a relationship between a landscape characteristic and some parameter for population performance. However, such a result does not necessarily tells us how a landscape should be managed if we want the species to persist. So we need to develop standards for sustainable habitat networks, based on the notion of minimal thresholds of spatial cohesion. Moreover, landscapes are not planned for single species and are not designed by ecologists. Therefore, we require a framework that helps us to integrate the variety of species requirements and spatial scale into a landscape level knowledge base. Finally, this knowledge must be available in different forms, tailored to the different requirements of knowledge application in the various phases of the planning process (for example assessment models next to design rules).

From a landscape ecological point of view, spatial ecology faces several future challenges. Up to now, metapopulation research has somewhat neglected environmental variation and assumed networks to be stable. To grow further and become a basic theory in nature conservation, metapopulation ecology should integrate the effects of small scale and wide scale disturbances (both natural and man induced effects). Also, it should be able to cope with multi-species effects.
Another major challenge lies in the predicted effects of climate change on populations. To develop a scientific basis for coping with this major threat on biodiversity, we must link biogeography, metapopulation ecology and climate change ecology. This requires scaling up of the metapopulation concept to the scale level of species ranges.

Close this window

Pretty patterns, obscure origins? A synthesis.

Prof. Dr. André De Roos .

Population Biology Section, University of Amsterdam, Kruislaan 320, 1098 SM Amsterdam, The Netherlands. Tel: +31 20 5257747, Fax: +31 20 5257754. Email: aroos@science.uva.nl. Click to see Andre de Roos' Homepage.

Without doubt the world around us is heterogeneous and the life of organisms is not only affected by this spatial heterogeneity, but organisms themselves are partly responsible for it. There is hence an intimate feedback between population-dynamic processes en patterns that can be distinguished in natural systems. If spatial ecology aims for unraveling these relations between patterns and processes, the BIGGEST PROBLEM (truly in capitals) is finding appropriate concepts and measures that (1) are measurable in the field, (2) predictable using spatial models, and (3) have significant resolution to separate alternative hypotheses from each other. For example, how do you test that spatial patterns, observed in nature and predicted to occur by some theoretical model, are really caused by the mechanism on which the model is based?

Pattern formation is such a general phenomenon that similar patterns can be obtained via different, mechanistic routes. If we really want to make progress in spatial ecology, we will have to go beyond general statements like: "It is possible that mechanism A is responsible for generating pattern B...". There are most probably 1001 other possible routes to the same end result.

In this concluding presentation I will give examples how different mechanisms may generate very similar patterns. Furthermore, on request of the organizers I will attempt to present a critical synthesis of the previous presentations.

Close this window