

Fred Jopp • Hauke Reuter • Broder Breckling  
Editors

# Modelling Complex Ecological Dynamics

An Introduction into Ecological Modelling  
for Students, Teachers & Scientists

Title Drawings by Melanie Trexler  
Foreword by Sven Erik Jørgensen  
& Donald L. DeAngelis



Springer

# Contents

## Part I Introduction

- 1 Backgrounds and Scope of Ecological Modelling: Between Intellectual Adventure and Scientific Routine** ..... 3  
Broder Breckling, Fred Jopp, and Hauke Reuter
- 2 What Are the General Conditions Under Which Ecological Models Can be Applied?** ..... 13  
Felix Müller, Broder Breckling, Fred Jopp, and Hauke Reuter
- 3 Historical Background of Ecological Modelling and Its Importance for Modern Ecology** ..... 29  
Broder Breckling, Fred Jopp, and Hauke Reuter

## Part II Modelling Techniques and Approaches

- 4 System Analysis and Context Assessment** ..... 43  
Broder Breckling, Fred Jopp, and Hauke Reuter
- 5 Steady State Models of Ecological Systems: EcoPath Approach to Mass-Balanced System Descriptions** ..... 55  
Matthias Wolff and Marc Taylor
- 6 Ordinary Differential Equations** ..... 67  
Broder Breckling, Fred Jopp, and Hauke Reuter
- 7 Partial Differential Equations** ..... 93  
Michael Sieber and Horst Malchow
- 8 Cellular Automata in Ecological Modelling** ..... 105  
Broder Breckling, Guy Pe'er, and Yiannis G. Matsinos

<b>9</b>	<b>Leslie Matrices</b> .....	119
	Dagmar Söndgerath	
<b>10</b>	<b>Modelling Ecological Processes with Fuzzy Logic Approaches</b> .....	133
	Agnese Marchini	
<b>11</b>	<b>Grammar-Based Models and Fractals</b> .....	147
	Winfried Kurth and Dirk Lanwert	
<b>12</b>	<b>Individual-Based Models</b> .....	163
	Hauke Reuter, Broder Breckling, and Fred Jopp	
<b>13</b>	<b>Modelling Species' Distributions</b> .....	179
	Carsten F. Dormann	
<b>14</b>	<b>Decision Trees in Ecological Modelling</b> .....	197
	Marko Debeljak and Sašo Džeroski	
<b>Part III Application Fields, Case Studies and Examples</b>		
<b>15</b>	<b>Neutral Models and the Analysis of Landscape Structure</b> .....	215
	Robert H. Gardner	
<b>16</b>	<b>Stage-Structured Integro-Differential Models: Application to Invasion Ecology</b> .....	231
	Aurélie Garnier and Jane Lecomte	
<b>17</b>	<b>Modelling Resilience and Phase Shifts in Coral Reefs: Application of Different Modelling Approaches</b> .....	241
	Andreas Kubicek and Esther Borell	
<b>18</b>	<b>Trophic Cascades and Food Web Stability in Fish Communities of the Everglades</b> .....	257
	Fred Jopp, Donald L. DeAngelis, and Joel C. Trexler	
<b>19</b>	<b>Lake Glumsø: Case Study on Modelling a Small Danish Lake</b> .....	269
	Søren Nors Nielsen and Sven Erik Jørgensen	
<b>20</b>	<b>Biophysical Models: An Evolving Tool in Marine Ecological Research</b> .....	279
	Alejandro Gallego	
<b>21</b>	<b>Modelling the Everglades Ecosystem</b> .....	291
	Fred Jopp and Donald L. DeAngelis	

<b>22 Model Integration: Application in Ecology and for Management</b> .....	301
Dietmar Kraft	
<b>Part IV Integrative Approaches in Ecological Modeling</b>	
<b>23 How Valid Are Model Results? Assumptions, Validity Range and Documentation</b> .....	323
Hauke Reuter, Fred Jopp, Broder Breckling, Christoph Lange, and Gerd Weigmann	
<b>24 Perspectives in Ecological Modelling</b> .....	341
Fred Jopp, Broder Breckling, Hauke Reuter, and Donald L. DeAngelis	
<b>Glossary</b> .....	349
<b>References</b> .....	355
<b>Index</b> .....	389