## Contents

		Preface p	age xi
		Acknowledgements	xiv
Part	I	Introduction to Community Ecology: Theory	
		and Methods	1
	1	Historical Development of Community Ecology	3
		1.1 What Is Community Ecology?	3
		1.2 What Is an Ecological Community?	4
		1.3 Early Community Ecology: A Descriptive Science	6
		1.4 Emergence of the First Theories	9
		1.5 Current Community Ecology: Search for the	
		Unifying Theory	11
	2	Typical Data Collected by Community	
		Ecologists	19
		2.1 Community Data	20
		2.2 Environmental Data	23
		2.3 Spatio-temporal Context	24
		2.4 Trait Data	26
		2.5 Phylogenetic Data	27
		2.6 Some Remarks about How to Organise Data	28
	3	Typical Statistical Methods Applied by Communit	y
		Ecologists	30
		3.1 Ordination Methods	30
		3.2 Co-occurrence Analysis	33
		3.3 Analyses of Diversity Metrics	34
		3.4 Species Distribution Modelling	35
	4	<b>An Overview of the Structure and Use of HMSC</b> 4.1 HMSC Is a Multivariate Hierarchical Generalised	39
		Linear Mixed Model	39

		-
V111	•	Contents

	4.2 The Overall Structure of HMSC	41
	4.3 Linking HMSC to Community Ecology Theory	45
	4.4 The Overall Workflow for Applying HMSC	47
Part II	Building a Joint Species Distribution Model Step	
	by Step	51
5	Single-Species Distribution Modelling	53
	5.1 How Do Species Distribution Models Link	
	to Species Niches?	53
	5.2 The Linear Model	55
	5.3 Generalised Linear Models	58
	5.4 Mixed Models	63
	5.5 Partitioning Explained Variation among Groups of Explanatory Variables	69
	5.6 Simulated Case Studies with HMSC	70
	5.7 Real Data Case Study with HMSC:	
	The Distribution of Corvus Monedula in Finland	92
6	Joint Species Distribution Modelling: Variation in	
	Species Niches	104
	6.1 Stacked versus Joint Species Distribution Models	104
	6.2 Modelling Variation in Species Niches in a	
	Community	107
	6.3 Explaining Variation in Species Niches by Their	
	Traits	110
	6.4 Explaining Variation in Species Niches by	
	Phylogenetic Relatedness	114
	6.5 Explaining Variation in Species Niches by Both	
	Traits and Phylogeny	117
	6.6 Simulated Case Studies with HMSC	120
	6.7 Real Case Study with HMSC: How Do	
	Plant Traits Influence Their Distribution?	133
7	Joint Species Distribution Modelling: Biotic	
	Interactions	142
	7.1 Strategies for Estimating Biotic Interactions in	
	Species Distribution Models	143
	7.2 Occurrence and Co-occurrence Probabilities	144
	7.3 Using Latent Variables to Model Co-occurrence	147

	Contents	· ix
	7.4 Accounting for the Spatio-temporal Context	
	through Latent Variables	152
	7.5 Covariate-Dependent Species Associations	156
	7.6 A Cautionary Note about Interpreting Residual	
	Associations as Biotic Interactions	159
	7.7 Using Residual Species Associations for Making	
	Improved Predictions	160
	7.8 Simulated Case Studies with HMSC	165
	7.9 Real Case Study with HMSC: Sequencing	
	Data on Dead Wood-Inhabiting Fungi	172
8	Bayesian Inference in HMSC	184
0	8.1 The Core HMSC Model	185
	8.2 Basics of Bayesian Inference: Prior and Posterior	100
	Distributions and Likelihood of Data	187
	8.3 The Prior Distribution of Species Niches	188
	8.4 The Prior Distribution of Species Associations	197
	8.5 The Prior Distribution of Data Models	206
	8.6 What HMSC Users Need and Do Not	200
	Need to Know about Posterior Sampling	207
	8.7 Sampling from the Prior with HMSC	210
	8.8 How Long Does It Take to Fit an	-10
	HMSC Model?	215
1		-10
9	Evaluating Model Fit and Selecting among	
	Multiple Models	217
	9.1 Preselection of Candidate Models	218
	9.2 The Many Ways of Measuring Model Fit	219
	9.3 The Widely Applicable Information	
	Criterion (WAIC)	225
	9.4 Variable Selection by a Spike and Slab Prior	228
	9.5 Reduced Rank Regression (RRR)	242
III	Applications and Perspectives	253
10	Linking HMSC Back to Community Assembly	
	Processes	255
	10.1 Simulating an Agent-Based Model of a	pplied
	Competitive Metacommunity	256
	10.2 Statistical Analyses of the Spatial Data Collected	
	by a Virtual Ecologist	266

Part

x · Contents

	10.3 Statistical Analyses of the Time-Series Data	
	Collected by a Virtual Ecologist	288
	10.4 What Did the Virtual Ecologists Learn from	
	Their Data?	297
11	Illustration of HMSC Analyses: Case Study of	
	Finnish Birds	. 300
	11.1 Steps 1–5 of the HMSC Workflow	300
	11.2 Measuring the Level of Statistical Support and	
	Propagating Uncertainty into Predictions	316
	11.3 Using HMSC for Conservation Prioritisation	321
	11.4 Using HMSC for Bioregionalisation: Regions of	
	Common Profile	324
	11.5 Comparing HMSC to Other Statistical Methods	
	in Community Ecology	329
12	<b>Conclusions and Future Directions</b>	
	12.1 The Ten Key Strengths of HMSC	337
	12.2 Future Development Needs	341
	n monta very canada abilitatical analysis of the second and the second s	0.17
	Epilogue	347
	References	350
	Index	369

The colour plates appear between pages 336 and 337