## Contents

			edulion dynamics in pateby an dount managin adult	
Pr	eface	1.4.2.2		xi
B	ook st	tructur	e interacting metaphosongraphic technical and off	xiv
A	cknov	wledge	ments	xvi
		42.3		
1	Intr	oductio		1
	1.1	The s	implifying assumptions of classical population	1
	10	dynar	nics	1
	1.2	Spalla	al extensions of the classical approach	4 5
	1.5	The	role of spatiotemporal models in ecology	10
	1.4	The I	ole of spatiotemporal models in ecology	10
Pa	art O	ne Spa	tial Mass-interaction Models	
2	Rea	ction-	diffusion models of population growth and dispersion	13
-	2.1	Intro	duction	13
	2.2	Rand	om walk approximations to diffusion	15
		2.2.1	Random walk in discrete time and space	15
		2.2.2	Random walk in continuous time and space	17
	2.3	The diffusion equation		
		2.3.1	The flow balance approximation to diffusion	24
		2.3.2	Density flow	26
		2.3.3	Diffusion in 2D and 3D spaces	27
		2.3.4	Methodological overview: initial and boundary	
			conditions, solutions, stability analyses and	
			numerical approximations of PDE models	29
		2.3.5	Solutions of the diffusion equation	34
		2.3.6	Density-dependent diffusion with biased random	
	~ .		walk	37
	2.4	Adve	ction	38
		2.4.1	Constant rate advection with step probability	-
		242	adjustment	39
		2.4.2	Constant rate advection with step length	10
		242	adjustment	40
	25	2.4.3 Dani	Advection induced by a milieu gradient	41
	2.5	React	Constant rate growth in diffusive systems	42
		2.5.1	The emitical hebitat size and history	43
		2.5.2	Density dependent growth and discussion	45
		2.3.3	Density-dependent growth and dispersion	46

	2.6	React	tion II: species interactions in diffusive systems	49
		2.6.1	The Lotka–Volterra diffusion model	49
		2.6.2	Diffusive instability in models of interacting species	52
		2.6.3	Competitive coexistence through habitat-partitioning	55
	2.7	Summ	nary	57
,	Dem	ulation	demonies in notable anninonments	50
3	Pop	Lation	dynamics in patchy environments	59
	3.1	Introc	auction	59
	3.2	I ne p	atch-abundance approach	61
		3.2.1	Basic assumptions of patch-abundance models	61
		3.2.2	The general model	62
	_	3.2.3	The problem of state variable choice	63
	3.3	Comp	betition and mutualism in dispersing island	
		popul	ations	63
		3.3.1	The multispecies multipatch Lotka–Volterra model	68
		3.3.2	Persistence and coexistence conditions	69
		3.3.3	Single species persistence: source-sink dynamics	73
		3.3.4	Habitat fragmentation effects	73
		3.3.5	Spatial pattern and competitive coexistence	74
		3.3.6	Single species resilience and risk spreading	76
	3.4	Preda	tion in patchy habitats	78
		3.4.1	Diffusive coupling of identical predator-prey	
			patches	82
		3.4.2	Dispersal asymmetry and stability in a two-patch	
			Lotka–Volterra model	86
		3.4.3	Aggregation and stability in a two-patch	
			environment	88
		3.4.4	The effects of predator mobility and delayed	
			functional response	94
	3.5	Chaot	tic dynamics of single-species systems in patchy	
		enviro	onments	95
		3.5.1	Migration against chaos: dispersion and stability in	
			coupled maps	96
		3.5.2	Coupled map lattices: the multipatch extension of	
			the coupled logistic model	99
		3.5.3	Self-organized criticality defeats chaos in a coupled	
			map lattice	104
	3.6	Summ	nary	109
	~		2.4.2 Constant rate advection with step length	
1	Spat	hally in	nplicit patch models: metapopulations and aggregated	111
	inte	raction	2.4.3 Advoction induced by a miliou gradient	III
	4.1	Introc	luction	111
	4.2	Metapopulations and metacommunities 11		
		4.2.1	Colonization-extinction equilibrium in the basic	- 1 · ·
			model	113

	4.2.2	The ghost of within-patch dynamics returns: the			
		asynchronous age-structured model	114		
	4.2.3	Metapopulations with synchronous local dynamics	117		
	4.2.4	Rescue effect due to spatial heterogeneity	120		
	4.2.5	Patch size and quality effects: phenomenological			
		model	122		
	4.2.6	Patch size and quality effects: mechanistic model	124		
	4.2.7	Multistate metapopulation models	125		
	4.2.8	Interacting metapopulations: the structure of	2.1.5		
		metacommunity models	130		
	4.2.9	Competitive metacommunities: continuous time			
		models	131		
	4.2.10	Discrete time metacommunity models	134		
	4.2.11	Comparing patch-abundance and patch-occupancy			
		models	136		
	4.2.12	Connection to island biogeography: incidence			
		function models	137		
4.3	Aggre	gation models of species interactions	140		
	4.3.1	The non-spatial reference: the Nicholson-Bailey			
		model	141		
	4.3.2	Spatial heterogeneity included: aggregation of			
		encounters in a patchy host distribution	144		
	4.3.3	Spatially undetermined aggregation of			
		interactions	149		
4.4	Summ	ary	151		
Part T	wo Neig	hbourhood Models of Population Interactions			
5 Sit	e-based r	neighbourhood models	155		
5.1	Introd	uction	155		
5.2	Interac	cting particle systems and cellular automata	156		
	5.2.1	The structure of interacting particle system	Appe		
		models	156		
	5.2.2	Mean-field approximations to interacting particle			
		systems	159		
	5.2.3	Aspects of complexity in interacting particle			
		systems	163		
5.3	Interac	cting particle systems and cellular automata in			
	ecolog	ecology			
	5.3.1	Discrete individuality and dynamical coexistence	165		
	5.3.2	Interacting particle system models of competing			
		metapopulations with temporary and permanent			
		habitat destruction	172		
	5.3.3	The temporal refuge effect in one-sided competition:			
		an example for a configuration-field approximation	174		

		5.3.4	The role of mesoscale patterns in the dynamics of	
			predator-prey cellular automata	182
		5.3.5	Plant competition along an environmental gradient	185
		5.3.6	Plant competition in a fractal environment	188
		5.3.7	The effect of clonal integration on plant competition	
			for mosaic habitat space	195
		5.3.8	Percolation models of spreading populations,	
			epidemics and forest fires	198
	5.4	Sumn	nary and all and adding the gathered at 8.5.4	199
;	Indi	vidual-	based neighbourhood models	202
	6.1	Intro	duction	202
	6.2	Tesse	llation models	203
		6.2.1	Predicting plant performance from tessellation	
			parameters: the Voronoi assignment model	206
		6.2.2	An interpretation of the self-thinning rule on the	
			individual level	207
		6.2.3	Tessellation models of territory establishment	210
		6.2.4	Towards tessellation dynamics: linking tessellations	
			to demography	212
		6.2.5	Towards multispecies tessellation dynamics:	
			weighted tessellations	213
	6.3	Dista	nce models	218
		6.3.1	Fixed radius neighbourhood models	220
		6.3.2	Zone of influence models	231
		6.3.3	Ecological field models	239
	6.4	Sumn	nary sector addressinged the elebeth bood modeled in own	242
	Epil	ogue		244
6.6		Chaol		5.1
Appendix A				
/b	opend	lix B		248
/b	openo	dix C		250
Re	ferei	nces		251
nc	lex			270