

TABLE OF CONTENTS

	Page
List of Publications	ix
List of Tables	xv
List of Figures	xvii
1 Introduction	1
1.1 What are biological invasions?	1
1.2 The relevance of biological invasions for science and society	3
1.3 Mathematical models in invasion biology	6
1.4 Differential equations as a tool to study biological invasions	8
1.4.1 Growth models	8
1.4.2 Interactions between two species	11
1.4.3 Interactions between more than two species	15
1.4.4 Spatial models	16
1.4.5 Stochastic differential equations	26
1.5 Outline	29
2 Wave pinning in competition-diffusion models in variable environments	33
2.1 Introduction	34
2.2 Model and methods	36
2.2.1 Deterministic model	36
2.2.2 Stochastic model	41
2.2.3 Numerical treatment	44
2.3 Wave pinning	44
2.3.1 Analytical review	44
2.3.2 Numerical results	46
2.3.3 Stability against environmental perturbations	47
2.4 Discussion and conclusions	51

TABLE OF CONTENTS

3	Invasion dynamics in an intraguild predation system with predator-induced defense	55
3.1	Introduction	56
3.2	Model and methods	57
3.3	Analytical results	61
3.3.1	Stationary solutions	61
3.3.2	Model with adaptivity	63
3.4	Numerical results	64
3.4.1	Nonspatial results	65
3.4.2	Spatial results	70
3.5	Discussion and conclusions	74
3.A	Appendix	76
3.A.1	Jacobian matrix for the model without adaptation	76
3.A.2	Nullclines of the model with adaptation	77
4	A type IV functional response with different shapes in a predator-prey model	79
4.1	Introduction	80
4.2	General model	81
4.3	Model with a given catch rate	86
4.4	Discussion and conclusions	92
4.A	Appendix	94
4.A.1	Timescale separation	94
4.A.2	Limit of $\eta(v)$	96
5	Taxis-driven pattern formation in a predator-prey model with group defense	97
5.1	Introduction	98
5.2	Model and methods	100
5.3	Results	102
5.3.1	Taxis-driven instability	102
5.3.2	Patterns in excitable media	104
5.3.3	Preytaxis in excitable media	111
5.4	Discussion and Conclusion	114
5.A	Appendix	116
5.A.1	Dimensions	116
6	Disease-induced chaos, coexistence, oscillations, and invasion failure in a competition-model with strong Allee effect	117
6.1	Introduction	118
6.2	Allee effect in a single species	119

6.3	Disease-free competition between two species	122
6.4	Competition-free <i>SI</i> -dynamics	123
6.4.1	Spatial analyses	127
6.5	Model including infection and competition	131
6.6	Impact of the disease on invasion dynamics	134
6.6.1	Invasion dynamics with strong competitive pressure	136
6.6.2	Invasion dynamics with weak competitive pressure	139
6.6.3	Spatial phenomena	140
6.7	Conclusions	143
6.A	Appendix	146
6.A.1	Wave speed in the single-species model	146
6.A.2	Nonspatial <i>SI</i> -model	146
6.A.3	Spatial <i>SI</i> -model	149
7	The necessity of tailored control of irrupting pest populations driven by pulsed resources	151
7.1	Introduction	152
7.2	Model	153
7.2.1	Pulsed resource	154
7.2.2	Generalist consumer	155
7.2.3	Generalist Predator	158
7.2.4	Metapopulation model	159
7.2.5	Plague metric	160
7.3	Results	161
7.3.1	Local dynamics	161
7.3.2	Metapopulation dynamics	162
7.4	Discussion	164
7.4.1	Control timing	164
7.4.2	Control intensity	165
7.4.3	Control Strategy	166
7.5	Conclusions	166
7.A	Appendix	168
7.A.1	Parameters	168
7.A.2	Killing proportion	170
7.A.3	Reinvasion time	171
8	Discussion and conclusions	173
8.1	Summary	173
8.2	Discussion	175

TABLE OF CONTENTS

8.2.1	General implications	175
8.2.2	General uncertainties and limitations	175
8.2.3	Recommendations	177
8.3	Outlook	179
8.3.1	Environmental stochasticity	179
8.3.2	Dispersal	180
8.3.3	Management	182
	References	185