

Population Ecology

First Principles

John H. Vandermeer
and
Deborah E. Goldberg

PRINCETON UNIVERSITY PRESS

PRINCETON AND OXFORD

C o n t e n t s

List of Figures	xi
List of Tables	xvii
Preface	xix

C H A P T E R 1

Elementary Population Dynamics	1
Density Independence: The Exponential Equation	3
Density Dependence: Intraspecific Competition	10
The Logistic Equation	14
The Yield–Density Relationship	21
Density Dependence and Mortality: Thinning Laws	26

C H A P T E R 2

Life History Analysis	35
Investment in Survivorship versus Reproduction:	
The r , K Continuum	37
Cost of Reproduction	41
Optimal Reproductive Schedules	44

C H A P T E R 3

Projection Matrices: Structured Models	51
Elementary Population Projection Matrices	52
Non-age Structure: Stage Projection Matrices	62

Eigenvectors, Reproductive Value, Sensitivity, and Elasticity	69
Applications of Population Projection Matrices	73
The Dall's Mountain Sheep: A Static Life Table	74
Palo de Mayo: A Dynamic Life Table	75
The American Beech: Testing Hypotheses with Dynamic Life Tables	77
Density Dependence in Structured Populations	80
Density Dependence in a Simple Age-Structured Model	81
Density Dependence in Size-Distributed Populations	84
Density Dependence in a Stage-Structured Model	92
Appendix A. Basic Matrix Manipulations	94

CHAPTER 4

A Closer Look at the "Dynamics" in Population Dynamics	101
Intuitive Ideas of Equilibrium and Stability	103
Eigenvalues: A Key Concept in Dynamic Analysis	114
Basic Concepts of Equilibrium and Stability in One-Dimensional Maps	120
The One-Dimensional Map	121
Stability and Equilibrium in the Logistic Map	130
Basins of Attraction in the Logistic Map	133
Structural Stability	135
Bifurcation Diagrams	142
Concluding Remarks	149

CHAPTER 5

Patterns in Space and Metapopulations	155
The Poisson Distribution	158
The Question of Scale	163
Metapopulations	167
Assumptions of Metapopulation Models	171
The Rescue Effect and Propagule Rain	173

CHAPTER 6

Predator–Prey (Consumer–Resource) Interactions	177
Predator–Prey Interactions: First Principles	179
Density Dependence	185

Functional Response	186
Functional Response and Density Dependence Together	193
Paradoxes in Applications of Predator–Prey Theory	195
Predator–Prey Dynamics: A Graphical Approach	198
Predator–Prey Interactions in Discrete Time	205

CHAPTER 7

Epidemiology	209
Direct Disease Transmission	210
Indirect Disease Transmission	217

CHAPTER 8

Competition and a Little Bit of Mutualism	221
Competition: First Principles	222
The Competitive Production Principle: Applications of Competition Theory to Agriculture	234
Mutualism	235
Competition: The Details	240

CHAPTER 9

What This Book Was About	255
Glossary	261
References	265
Index	273