# **Table of contents**

List of boxes ix

Preface to second edition xi

Preface to first edition xii

List of symbols xiv

Acknowledgments for second edition xv

Acknowledgments for first edition xvi

# Part I Background To Applied Population Biology 1

# 1 The Big Picture: Human Population Dynamics Meet Applied Population Biology 3

Introduction 3

Population Ecology of Humans 4

Extinction Rates of Other Species 8

Humans and Sustainable Harvest 12

The Big Picture 13

Further Reading 13

# 2 Designing Studies and Interpreting Population Biology Data: How Do We Know What We Know? 14

Introduction 14

Obtaining Reliable Facts Through Sampling 15

Linking Observed Facts to Ideasmind Leads to Understanding 19

Ethics and the Wildlife Population Biologist 29

Summary 31

Further Reading 32

# 3 Genetic Concepts and Tools to Support Wildlife Population Biology 33

Introduction 33

What Is Genetic Variation? 33

Genetic Markers Used in Wildlife Population Biology 35

Insights into Wildlife Population Biology Using Genetic Tools 43

Summary 52

Further Reading 53

# 4 Estimating Population Vital Rates 54

Introduction 54

Estimating Abundance and Density 54

Survival Estimation 67

Estimation of Reproduction 70

Sex Ratio 71

Summary 74

Further Reading 75

# Part II Population Processes: The Basis For Management 77

# 5 The Simplest Way to Describe and Project Population Growth: Exponential or Geometric Change 79

**Introduction 79** 

Fundamentals of Geometric or Exponential Growth 80

Causes and Consequences of Variation in Population Growth 84

Quantifying Exponential Population Growth in a Stochastic Environment 91

Summary 96

Further Reading 97

# 6 All Stage Classes are Not Equal in Their Effects On Population Growth: Structured Population-Projection Models 98

**Introduction 98** 

Anatomy of a Population-Projection Matrix 99

How Timing of Sampling Affects the Matrix 100

Projecting a Matrix Through Time Leads to Transient and Asymptotic Dynamics 103

All Vital Rates are not Created Equal: Analytical Sensitivities and Elasticities 108

Stochasticity in Age and Stage-Structured Populations 109

Sensitivity Analysis in the Broad Sense to Help Evaluate Management Actions 113

Fitness is Lambda, Selection is Management 116

Case Studies Using Matrix Models to Guide Conservation Decision-Making 118

Summary 124

Further Reading 125

# 7 Density-Dependent Population Change 126

Introduction 126

Negative Density Dependence 126

The Logistic: One Simple Model of Negative Density-Dependent Population Growth 128

Some Counterintuitive Dynamics: Limit Cycles and Chaos 133

Positive Density Dependence 135

Negative and Positive Density Dependence Operate Together 138

Component Versus Demographic Outcomes of Density Dependence 140

Summary 140

Further Reading 141

### 8 Predation and Wildlife Populations 142

Introduction 142

Does Predation Affect Prey Numbers? 143

Factor 1. Determining How Predation Affects Prey Numbers: Predation Rate 145

Factor 2. Determining How Predation Affects Prey Numbers: Compensation 150

Factor 3. Determining How Predation Affects Prey Numbers: Who Gets Killed 152

Summary 152

Further Reading 153

# 9 Genetic Variation and Fitness in Wildlife Populations 154

Introduction 154

Long-Term Benefits of Genetic Variation 154

What Determines Levels of Genetic Variation in Populations? 155

Quantifying the Loss of Heterozygosity: The Inbreeding Coefficient 161

When Does Inbreeding Due to Genetic Drift Lead to Inbreeding Depression? 162

Outbreeding Depression and the Loss of Local Adaptation 165

Genetic Rescue, Genetic Restoration, and Long-Term Population Recovery 167

Appropriate Levels of Genetic Connectivity 168

Case Studies Where Genetic Rescue Meets the Real World 169

Summary 173

Further Reading 174

### 10 Dynamics of Multiple Populations 175

Introduction 175

What Is Connectivity? 176

Consequences of Connectivity for Wildlife Populations 177

Measuring Connectivity Among Wildlife Populations 177

Multiple Populations are not All Equal 185

Options for Restoring Connectivity 194

Summary 197

Further Reading 198

Part III Applying Knowledge of Population Processes To Problems of Declining, Small, or Harvestable Populations 199

11 Human-Caused Stressors: Deterministic Factors Affecting Populations 201

Introduction 201

General Effects of Deterministic Stressors on Populations: Adapt, Move, or Die 201

Habitat Loss and Fragmentation 203

Introduced and Invasive Species 206

Pollution 212

Overharvest 214

Global Climate Change 215

Multiple Deterministic Stressors Occur Simultaneously 220

Summary 222

Further Reading 223

# 12 Predicting The Dynamics of Small and Declining Populations 224

Introduction 224

Ecological Characteristics Predicting Risk 224

The Extinction Vortex 226

Predicting Risks in Small Populations 226

Population Viability Analysis (PVA): Quantitative Methods of Assessing Viability 227

Other Approaches to Assessing Viability 239

Summary 242

Further Reading 243

### 13 Focal Species To Bridge From Populations To Ecosystems 244

Introduction 244

The Four Categories of Focal Species 245

Summary 249

Further Reading 250

# 14 Population Biology To Guide Sustainable Harvest 251

Introduction 251

Effects of Hunting on Population Dynamics 252

Long-Term Effects: Hunting as an Evolutionary Force 257

Models to Guide Sustainable Harvest 258

Waterfowl Harvest and Adaptive Harvest Management in the US 264

Management of Overabundant and Pest Populations 265

Summary 266

Further Reading 267

Epilogue 269

References 271

Index 301