

Contents

<i>Preface</i>	xi
<i>Acknowledgments</i>	xv
<i>List of Symbols</i>	xix
1 Introduction	1
Why should we conserve genetic diversity?	2
What genetic problems occur in fragmented populations?	5
Can we reverse the adverse effects of population fragmentation?	6
How important is genetic management of fragmented populations?	8
How should we genetically manage fragmented populations?	11
Summary	13
Further Reading	14
Section I Genetic problems in small isolated populations	15
2 Evolutionary genetics of small populations	17
Background	18
What factors control the evolution of small populations?	18
What genetic markers are used in conservation genetics?	26
How do we measure and describe genetic diversity?	27
How much standing genetic diversity do species and populations contain?	28
How do we measure population size?	31
Why is inbreeding important in conservation?	34
Why do we use computer simulations in conservation genetics?	37
Summary	39
Further Reading	39
Software	40
3 Inbreeding reduces reproductive fitness	41
Why is inbreeding an important issue in conservation?	42
Why is inbreeding harmful?	43
What factors affect the magnitude of inbreeding depression?	44
How large are the impacts of inbreeding on total fitness?	53
Does inbreeding increase extinction risks?	54
How do we detect inbreeding depression?	58
How do we quantify inbreeding depression?	58

Contents

What is mutational meltdown?	62
What are the relationships between harmful mutation, drift, inbreeding, fixation, and fitness decline?	62
Can we reverse inbreeding depression and mutational accumulation?	63
Summary	64
Further Reading	64
Software	64
4 Loss of genetic diversity reduces ability to adapt	65
Why should we be concerned about conserving the ability of species to adapt?	66
How common is evolutionary adaptation?	67
How rapidly does adaptation occur?	67
How large are adaptive evolutionary changes?	69
What determines the ability to undergo adaptive evolution?	71
How can we measure evolutionary potential?	84
Can we restore the ability to evolve?	85
Summary	85
Further Reading	86
Software	86
5 Population fragmentation causes inadequate gene flow and increases extinction risk	87
Why is population fragmentation important in conservation?	88
How frequently are there problems due to inadequate gene flow?	91
What are the genetic consequences of completely isolated fragments?	91
What are the consequences of gene flow among fragments?	97
What are the consequences of different fragmented population structures?	100
Complex relationships among variables in real fragmented populations	104
How do we measure genetic differentiation among populations?	106
Summary	111
Further Reading	112
Software	112
Section II Rescue and risk	113
6 Genetic rescue by augmenting gene flow	115
What are the problems of genetic erosion in small isolated population fragments?	116
Can we reverse inbreeding and loss of genetic diversity?	117
Does crossing have beneficial or harmful effects on fitness?	118
Are immigrant alleles at a selective advantage?	131

Contents

How large and consistent are evolutionary rescue effects?	132
Summary	134
Further Reading	134
7 Outbreeding depression is uncommon and predictable	135
Why are we concerned about harmful crosses?	136
What mechanisms generate outbreeding depression?	140
How many generations does it take to develop outbreeding depression?	149
Can we predict the risk of outbreeding depression?	150
At what generation after crossing is outbreeding depression evident?	153
Can populations recover from outbreeding depression?	154
Summary	154
Further Reading	155
8 Modified rescue and risk expectations for species with diverse mating systems and modes of inheritance	156
Why do we need to consider diverse mating systems and modes of inheritance?	157
How are genetic rescue and risk expectations modified for different mating systems?	158
How can we identify mating systems?	166
How are genetic rescue and risk expectations modified for different modes of inheritance?	169
How do we identify modes of inheritance?	175
Summary	176
Further Reading	177
Software	178
Section III Developing management decisions	179
9 Is the taxonomy appropriate? Delineating species for conservation purposes	181
What is the role of species delineation in conservation?	182
What is our objective?	182
How do we characterize population genetic differentiation in taxonomy?	182
What problems occur with species delineations?	184
Which species definitions are appropriate for conservation purposes?	196
How do we decide whether taxonomic revision is required?	200
How should a taxonomic re-evaluation be conducted if required?	201
Conclusions	201
Summary	201
Further Reading	202
Software	202

10	Determining the number and location of genetically differentiated population fragments	203
	What are our objectives?	204
	How do we identify the number of genetically differentiated populations?	205
	How do we locate genetically differentiated populations in the landscape?	209
	Are current units within species suitable for genetic management purposes?	211
	What is the current recommendation when genetically differentiated populations are identified?	214
	How should we proceed when there are genetically diverged populations?	216
	How can we measure gene flow among population fragments?	217
	Summary	221
	Further Reading	222
	Software	222
11	Are there populations suffering genetic erosion that would benefit from augmented gene flow?	223
	What are our objectives?	224
	Are there guidelines for genetic rescues?	226
	What questions do we need to answer?	229
	Are any populations suffering genetic erosion?	229
	Is there another population to which it can be crossed?	233
	Will crossing result in outbreeding depression?	233
	Will crossing result in worthwhile genetic rescue?	239
	How do we cope with simultaneous harmful and beneficial effects of crossing?	243
	Summary	243
	Further Reading	243
	Software	244
12	Managing gene flow among isolated population fragments.	
	I. Limited information	245
	Why do we need to manage gene flow?	246
	How can we augment gene flow?	248
	What is the objective of genetic management for isolated population fragments?	249
	Genetic management with different amounts of information	250
	What can be done with little or no genetic information?	251
	Genetic swamping	263
	Summary	264
	Further Reading	265
	Software	265

Contents

13 Managing gene flow among isolated population fragments.	
II. Management based on kinship	266
How does detailed genetic information aid management of gene flow?	267
What population genetic parameter should we manage?	270
How do we manage using mean kinship?	272
Population mean kinship	277
Kinships at the individual level	281
Managing gene flow at the individual level	283
When to cease?	287
What genetic monitoring is needed?	287
Integrating genetic rescue with other management considerations	288
Summary	288
Further Reading	289
Software	289
14 Global climate change increases the need for genetic management	291
What is the problem?	292
Why does global climate change increase the need for genetic management?	294
How have species responded to global climate change?	296
What genetic management options do we have for populations that cannot move or adapt sufficiently?	298
How do we implement genetic management to assist adaptation?	300
How do we decide what populations and species need translocation to avoid extinction?	303
How should we genetically manage translocations to cope with climate change?	304
Summary	310
Further Reading	311
Software	311
15 Take home messages	312
Final messages for managers of wild animal and plant populations	313
Glossary	315
References	327
Index	391
APPENDICES (available online at www.oup.co.uk/companion/frankham)	A1
1 Genetic markers for conservation purposes	A1
2 VORTEX simulation software for population viability analysis	A7
3 How should a taxonomic re-evaluation be conducted if required?	A12