

Contents

<i>Preface</i>	ix
<i>Take home messages</i>	xv
<i>Acknowledgments</i>	xvii
<i>List of symbols</i>	xxi
1 Introduction	1
Why do we need genetic management of species?	2
Genetic problems are typically worse in fragmented than continuous populations	5
The adverse effects of population fragmentation can usually be reversed by gene flow	6
Importance of genetically managing fragmented populations	7
How should we genetically manage fragmented populations?	10
Summary	11
Further reading	12
Section I Genetic problems in small isolated populations and their remedies	13
2 Evolutionary genetics of small populations	15
Background	16
Populations evolve through the impacts of mutation, selection, chance, and gene flow	16
How do we measure and describe genetic diversity?	20
Small populations have reduced levels of genetic diversity	22
Genetic impacts depend upon the genetically effective population size, rather than the census size	22
Inbreeding reduces fitness and increases extinction risk	26
Summary	28
Further reading	28
Software	29
3 Inbreeding and loss of genetic diversity increase extinction risk	31
Genetic erosion is unavoidable in small isolated populations	32
Inbreeding reduces fitness	32
Factors affecting the magnitude of inbreeding depression	33
Inbreeding effects on total fitness are typically extremely harmful	37

Comparisons of inbred and outbred individuals in the same environment are required to detect inbreeding depression	40
Evolutionary changes may allow populations to cope with conditions that they could not previously tolerate	42
To evolve, species need genetic diversity, reproductive excess, and selection	43
Inbreeding depression and compromised ability to adapt can often be reversed by gene flow	46
Summary	46
Further reading	47
Software	47
4 Population fragmentation causes inadequate gene flow and increases extinction risk	49
Most species have fragmented distributions, many with adverse genetic effects on population persistence	50
Genetic problems due to inadequate gene flow are widespread	53
Harmful genetic effects are worse in completely isolated fragments	53
Gene flow reduces the harmful genetic effects of population fragmentation	56
The genetic consequences of different fragmented population structures vary	57
How do we measure genetic differentiation among populations?	58
The number of populations can be estimated from the number of genetic clusters	60
Summary	64
Further reading	64
Software	64
5 Genetic rescue resulting from gene flow	65
Genetic erosion occurs in many small isolated population fragments	66
Inbreeding and loss of genetic diversity can be reversed by gene flow from another population	66
Crossing can have beneficial or harmful effects on fitness	67
Fitness benefits from genetic rescues are large and consistent	67
Gene flow enhances the ability to evolve (evolutionary rescue)	73
The mechanisms generating outbreeding depression are known	74
Populations usually recover from outbreeding depression over generations	78
Conclusion	78
Summary	79
Further reading	79
Section II Making genetic management decisions	81
6 Appropriate delineation of species for conservation purposes	85
Appropriately resolved taxonomy is crucial to conservation management	86

What is our objective?	86
Characterizing genetic differentiation in taxonomy	86
There are many problems with species delineations	87
Species definitions used in conservation should not compromise species persistence	92
Taxonomic revisions will often be required for species with allopatric distributions delineated using PSC or GLSC	94
How should a taxonomic re-evaluation be conducted if required?	95
Some populations within species may be sufficiently distinct to justify separate management	95
Summary	95
Further reading	96
Software	96
7 Are there populations suffering genetic erosion that would benefit from gene flow?	97
Separate management of genetically differentiated populations is often recommended	98
Objectives	100
What questions should we ask, having established the presence of multiple populations?	100
Question 2: Are any populations suffering genetic erosion?	103
Question 3: Is there another population to which it can be crossed?	105
Question 4: Will gene flow result in outbreeding depression?	106
Question 5: Will gene flow result in worthwhile genetic rescue?	109
Summary	112
Further reading	113
Software	113
8 Managing gene flow among isolated population fragments	115
Genetic management of gene flow among population fragments is needed to optimize genetic benefits in a cost-effective manner	116
Gene flow can be established by connecting habitat fragments or moving genetic material between them	118
Objectives	118
What questions should we ask?	119
Management of gene flow with minimal information	119
Management of gene flow with detailed genetic information	124
Restoring genetic diversity by gene flow based on minimizing mean kinship between populations	129
Populations should be monitored to confirm that augmentation has resulted in intended benefits	131
Integrating genetic rescue with other management considerations	132
Summary	132

Further reading	132
Software	133
9 Global climate change increases the need for genetic management	135
Global climate change is harming many species and its impacts are projected to worsen	136
Species have responded to global climate change by moving, adapting, or going extinct	138
Genetic management options for populations that cannot move or adapt sufficiently	140
Identifying populations incapable of adapting rapidly enough or moving	141
Implementing genetic management to assist evolutionary adaptation	142
Genetically managing translocations to cope with climate change	144
Summary	147
Further reading	148
Software	148
Final messages for managers of wild animal and plant populations	149
Glossary	151
References	157
Index	169
APPENDICES (available online at http://www.oup.co.uk/companion/FrankhamPG)	A1
1 Genetic markers for conservation purposes	A1
2 N_e/N ratio estimates for diverse taxa	A7
3 How should a taxonomic re-evaluation be conducted if required?	A15
4 VORTEX simulation software for population viability analysis	A20
5 References common to this book and <i>Genetic Management of Fragmented Animal and Plant Populations</i>	A26